*03M11B25*

TEKTRONIX®

# TYPE RM529 MOD 188D WAVEFORM MONITOR

ABOVE SN 9,500

INSTRUCTION MANUAL

# INSTRUCTION MANUAL

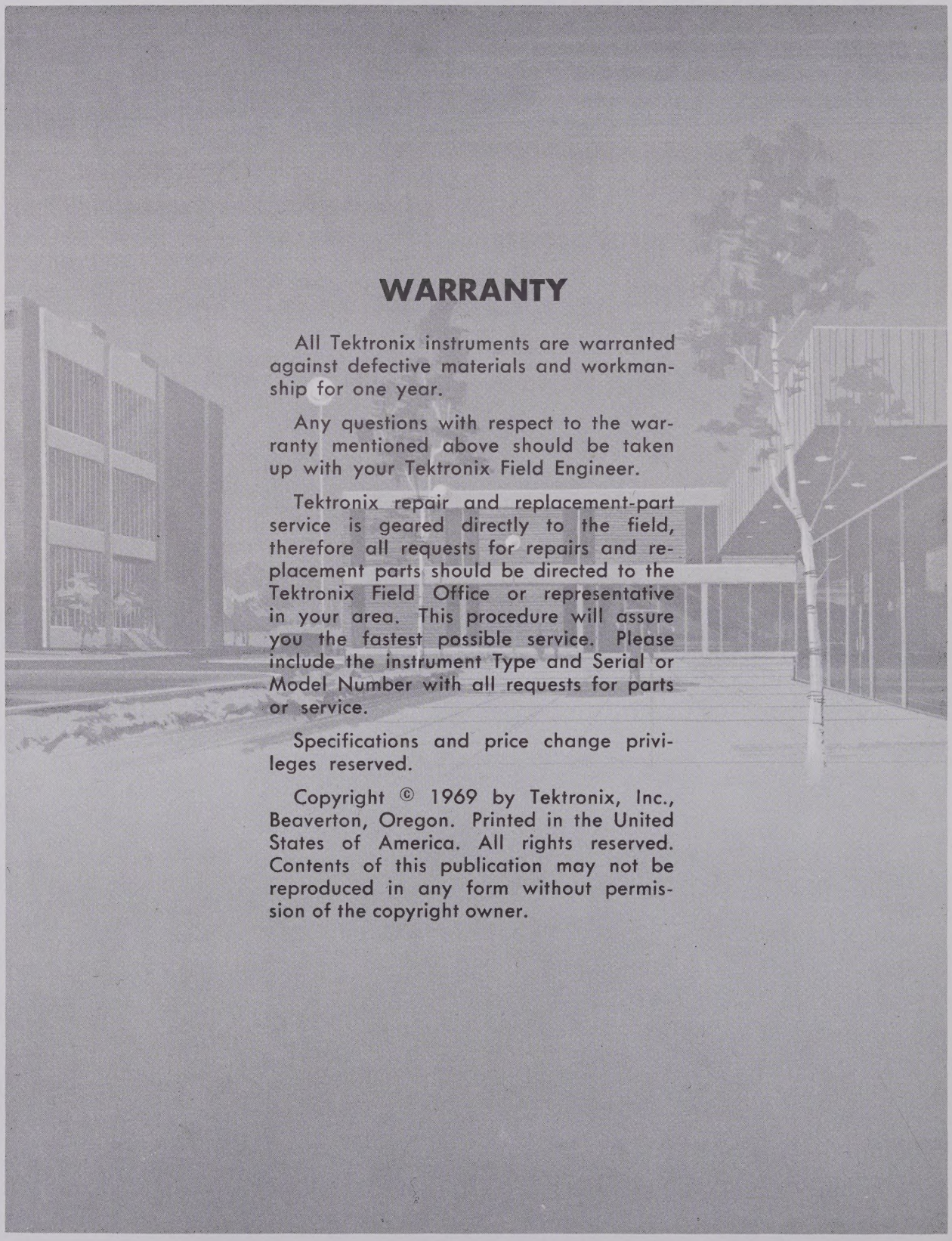
Serial Number _____

**TYPE RM529 MOD 188D**

**WAVEFORM MONITOR**

**ABOVE SN 9,500**

*Tektronix, Inc.*
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix
070-0926-00



# WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units". MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

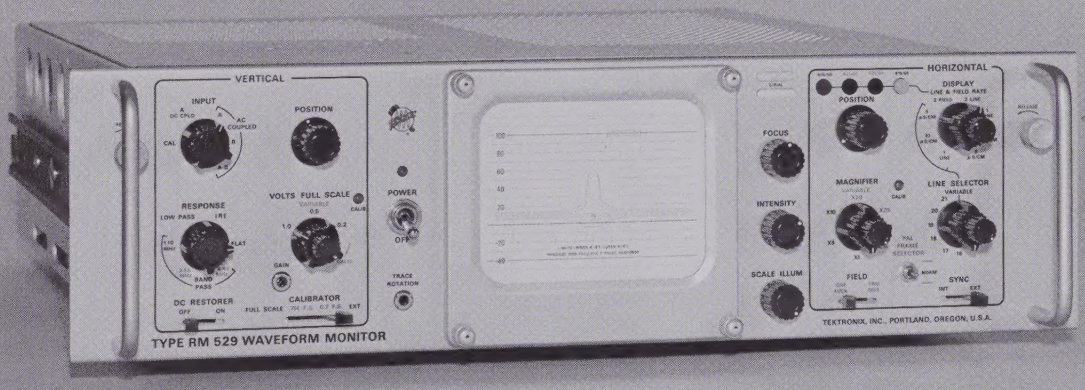



Fig. 1-1. Type RM529 Waveform Monitor.

# SECTION 1
# CHARACTERISTICS

Change information, if any, affecting this section will be found at the rear of the manual.

## General Information

The Tektronix Type RM529 MOD 188D Waveform Monitor is a self-contained Cathode-ray oscilloscope specifically designed for video-waveform monitoring at all 405/50, 525/60, 625/50, and 819/50 line and field rate television transmitters and studio facilities. With this monitor, any portion of the television-signal waveform can be displayed on a 5-inch rectangular cathode-ray tube.

A frequency-response switch is included which enables the selection of several frequency-response characteristics including that characteristic recommended by the IEEE Standards Committee for standardized pulse-level measurements.

An internal 30-kHz amplitude calibrator provides 0.7-volt, 0.714-volt or 1.0-volt pulses for calibrating the vertical amplifier. The sweep system provides calibrated sweeps on each of the line and field rates which eliminates the need for time markers.

The following characteristics apply over an ambient temperature range of 0° C to 50° C. Warm-up time for the given accuracies is 20 minutes at 25° C, ±5° C.

The performance requirements throughout this manual are stated in either percentage or IRE units. The comparable dB points are determined using the formula:

$$dB = 20 \log \frac{E1}{E2}.$$

## ELECTRICAL CHARACTERISTICS

TABLE 1-1

Vertical Deflection System

| Characteristic | Performance Requirement |
|---|---|
| Frequency Response: FLAT (1 V gain sensitivity) | Flat to within +0%, −1% (0.1 dB) from 50 Hz to 6 MHz. Flat to within +0%, −3% (0.3 dB) from 50 Hz to 8 MHz. |
| FLAT (0.2 and 0.5 gain sensitivities) | Flat to within +0%, −1% (0.1 dB) from 50 Hz to 6 MHz |
| LOW PASS | At least 80% down at 500 kHz. |
| BANDPASS | Provides ×2 (±5%) gain increase of a 1.10 MHz signal. 1.10 MHz center frequency; must be no more than 10% down in amplitude at 0.9 MHz and 1.3 MHz and at least 87.5% (18 dB) down at 0.2 MHz. |
| 3.58 MHz | Provides a ×1 (±3%) gain increase of a 3.58 MHz signal. 3.58 MHz center frequency; must be 15% to 35% down in amplitude at 3.18 MHz. |
| 4.43 MHz | Provides a ×2 (±3%) gain increase of a 4.43 MHz signal. 4.43 MHz center frequency; must be 15% to 35% down in amplitude at 3.93 MHz and 5.13 MHz. |
| IRE | Response per 1958 IRE STD 23S-1 (see Fig. 1-2). Signal will be 2% to 6.1% down at 4.43 MHz. |
| Transient Response: High Frequency | 125 ns H.A.D. (half amplitude duration) $\sin^2$ (sine squared) pulse and bar signal must be between 97 and 100 IRE units high for 100 IRE units of bar signal amplitude applied. |
| Middle Frequency | Top of a 100 IRE units bar signal must be flat within ±½ IRE unit. |
| Overshoot | 2 IRE units or less of overshoot on A $\sin^2$ pulse and bar signal 100 IRE units in amplitude. |
| Gain Sensitivity | 1 V Full Scale Adjustable to 1 V (normally within 1%). 0.2 V Full Scale-within 1%. |
| Variable Gain Sensitivity | Must attenuate by a ratio of at least 2.5:1. |
| Vertical Position Direction | Clockwise rotation of control moves trace up. Counterclockwise rotation of control moves trace down. |
| Maximum Display Amplitude | 200 IRE units |
| Maximum Return Loss Video Inputs A | At least 46 dB when input terminated with 75 ohms. |
| Video Inputs B | At least 46 dB when input terminated with 75 ohms. |
| Video Output: Low Frequency Transient Response | The top of the bar portion of a 125 ns H.A.D. $\sin^2$ pulse and bar signal 100 IRE units in amplitude must not have more than 3% tilt. The tilt is expressed as a percentage of the total peak-to-peak amplitude of the measured signal. |

TABLE 1-2
Horizontal Deflection System

| Characteristic | Performance Requirement |
|---|---|
| Line and Field Rate Selector | Changes the sweep timing of the DISPLAY switch 1 LINE, 2 LINE and 2 FIELD position to correspond to the line and field rate of the system being viewed (405/50, 525/60, 625/50 or 819/50). |
| Calibrated Sweep Rate Accuracy: ×1 | Within 3% except in the 2 FIELD position of DISPLAY switch. |
| ×5 | Within 3% (sweep error + magnifier error) |
| ×10 | Within 4% (sweep error + magnifier error) |
| ×20 | Within 5% (sweep error + magnifier error) |
| Variable Magnifier Range | At least a 20% increase and decrease in horizontal display size referenced to display size with control in calibrated position. |
| Trace Length 2 field | At least 9.8 cm and not more than 10.4 cm. |
| All remaining sweep rates | At least 9.8 cm. |
| Horizontal Position Direction | Clockwise rotation of control moves trace to the right. Counter clockwise rotation of control moves trace to the left. |
| RGB/YRGB Sweep Length RGB (3 step) | 3.3 cm or less |
| YRGB (4 step) | 2.5 cm or less |
| Input Resistance (pin C of J501) | Variable from 220 kΩ to 1.1 mΩ by the INPUT LEVEL control. |
| Line Selector (Discrete) | Selects 16th through 21st line as indicated by the front panel markings.<br>The discrete line selector only functions in the 525/60 and 625/50 positions of the LINE & FIELD RATE switch. |
| Line Selector (Variable) Maximum Delay | Brightening pulse mus. extend into adjacent field by at least 25%. |
| Minimum Delay | Brightening pulse must start on or before the 20th horizontal line for 525/60, 405/60 and 625/50 television systems and on or before the 30th horizontal line for a 819/50 television system. |
| Field Selector One (Even per CCIR) | Triggers on field one and displays field two at screen center. |
| Two (Odd per CCIR) | Triggers on field two and displays field one at screen center. |

TABLE 1-3
Triggering

| Characteristic | Performance Requirement |
|---|---|
| External Trigger | Stable triggering must be obtained on an input comjosite video signal 400 mV or less and not greater than 1 V in peak to peak amplitude. |
| Internal Trigger | Stable triggering must be obtained on an input composite video signal 200 mV or less and not greater than 1 V in peak to peak amplitude. |

TABLE 1-4
Calibrator

| Characteristic | Performance Requirement |
|---|---|
| Signal Accuracy FULL SCALE | Within 1% of 1 V. |
| .714 FS | Within 1% of 0.714 V. |
| 0.7 FS | Within 0.5% of 0.7 V. |

TABLE 1-5
Power Supply

| Characteristics | Performance Requirement | | | |
|---|---|---|---|---|
| Power Source | This instrument is designed to be operated on an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused). The power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. | | | |
| Line Voltage Ranges | 94.5 volts AC to 132 volts AC, 189 volts AC to 264 volts AC. | | | |
| Line Frequency Range | 48 Hz to 66 Hz. | | | |
| Maximum Power Consumption | 115 VAC | | 125 VAC | |
| | 50 Hz | 60 Hz | 50 Hz | 60 Hz |
| | 98 W | 96 W | 119 W | 117 W |

TABLE 1-6
CRT Display

| Characteristic | Performance Requirement |
|---|---|
| Type 5290 Scan Area | At least 170 IRE units vertically by at least 10 cm horizontally (120 units on a 100 units graticule). |
| Beam Intercept Vertical | At 170 IRE units (70 mm) of scan maximum intercept per plate is equal to 40%. |
| Horizontal | At 10 cm of scan, maximum intercept per plate is equal to 70%. |

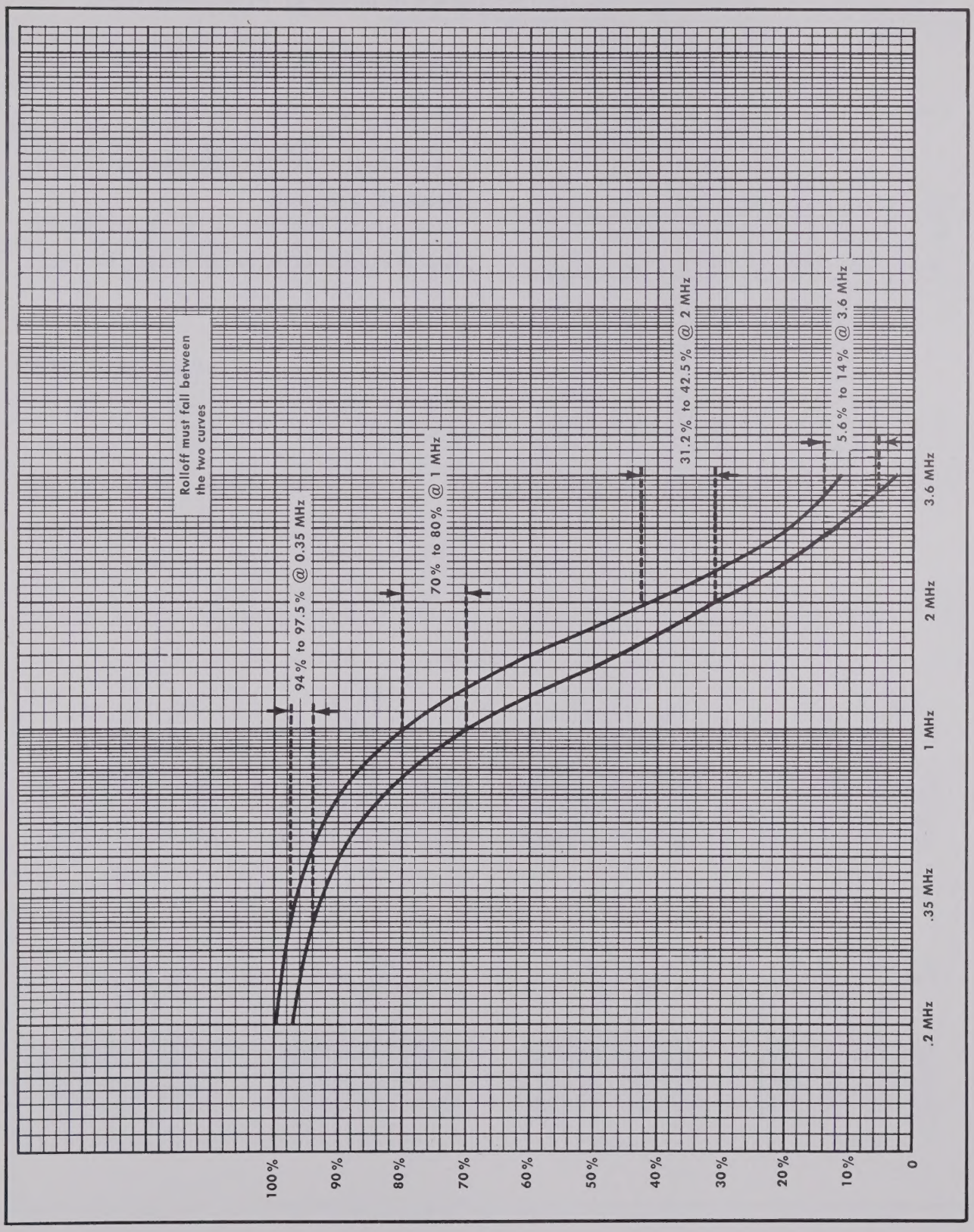



Fig. 1-2. IRE 1958 Standard 23S-1.

| Characteristics | Performance Requirement |
|---|---|
| Spot Centering | Must be within a radius of 0.5 cm from the mechanical graticule center. |
| Linearity | Must be less than 1 mm of compression or expansion of a 50 IRE units high signal anywhere in the scan area. |
| Orthogonality | Within 1°. |
| Raster Distortion | 1 mm or less in total. |
| Trace Rotation Range | At least 6°. |

## PHYSICAL CHARACTERISTICS

TABLE 1-7

| Characteristic | Information |
|---|---|
| Construction | Aluminum-alloy chassis and panel. |
| Finish | Anodized panel. |
| Overall Dimensions (measured at maximum points) | 5¼ inches (13.3 cm) high, 19 inches (48.3 cm) wide, 20 inches (50.8 cm) long (includes front panel knobs). |

### Standard Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list. For additional accessories, see the current Tektronix, Inc. catalog.

# SECTION 2
# OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

## General

This section of the manual provides general operating information. Included is a brief description of the Type RM529 MOD 188D controls and a suggested first-time operating procedure.

## Power Requirements

The regulated power supplies in the Type RM529 MOD 188D will operate properly with line voltages from 94.5 to 132 VAC or from 189 to 264 VAC. The line-voltage for which your instrument is wired at the factory is indicated by an adjustable, metal, voltage indicator tag fastened to the rear panel near the power receptacle.

The power transformer is wound with two multiple-tap 120-volt primaries, connected as shown in Fig. 2-1 for the different line-voltages. When the transformer connections are changed, the voltage indicator tag screw should be loosened and the metal tag set so the new line-voltage appears in the window of the tag, then tighten the screws.

For maximum dependability and long life, the line voltage applied to the Type RM529/MOD 188D should be the voltage indicated on the tag. If the line voltage exceeds the operating limits, or has a poor waveform (distorted sine waves), unstable power-supply operation may result. Check for proper line voltage and waveform before checking for other causes of unstable operation.

## Cooling

The Type RM529 MOD 188D is cooled by convection air flow through the instrument. If possible, allow two inches clearance at the sides and rear of the instrument for proper air circulation. Temperature of the circulating air should not exceed 50° C (122° F) for safe operation.

## Radiation

To prevent high-voltage power-supply radiation (30-kHz and harmonics from affecting the Type RM529 MOD 188D.

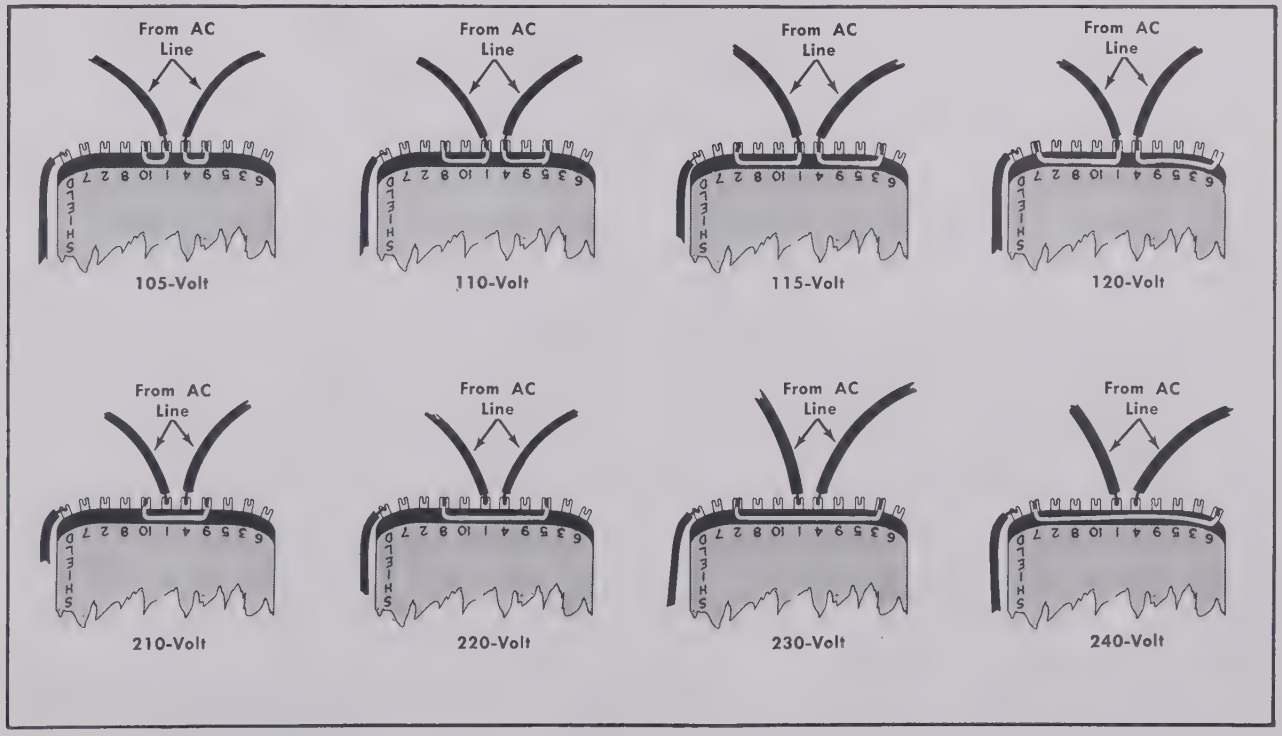



Fig 2-1. Power Transformer connections for the various line-voltages.

display and adjacent instruments in the rack, it is important to keep the top and bottom dust covers in place.

## FUNCTION OF FRONT-PANEL CONTROLS AND CONNECTORS

### VERTICAL CONTROLS

INPUT

Five-position switch to select one of four input signals: internal calibrator, input A DC coupled, input A AC coupled, input B AC coupled or A-B differential.

POSITION

Positions the trace vertically on the CRT.

RESPONSE

Six-position switch to select the amplifier frequency-response characteristics as listed in Section 1 of this manual.

VOLTS FULL SCALE

Three-position switch to select the calibrated vertical gain settings of 1.0, 0.5 and 0.2.

VARIABLE (VOLTS FULL SCALE)

Variable control with a minimum range of 2.5 to 1 to permit variable adjustment of gain between VOLTS FULL SCALE switch settings. When the VARIABLE control is set to CALIB, the CALIB neon lamp turns on to provide a visual indication that this is the calibrated gain setting.

GAIN Adjustment

A screwdriver adjustment to reset the vertical calibration of the instrument.

DC RESTORER

Two-position lever switch for turning the DC Restorer circuit off and on. This circuit is not a signal clamp. Instead, it is a keyed DC Restorer circuit which stabilizes the blanking pulse back porch at a constant level on the CRT, despite changes in signal amplitude or average luminance. The DC-restoration time constant is sufficiently long so that hum and tilt in the video signal will be displayed. This circuit eliminates DC drift of the vertical amplifier, making it unusually stable. There is no distortion, clipping, or degradation of the color-burst signal. The presence of the color burst does not cause the base line to shift.

CALIBRATOR

Four-position level switch that selects either 100, 71.4 or 70 units of signal according to the graticule marking, or selects an external calibration signal.

POWER

Control for turning the instrument power on and off.

TRACE ROTATION

Control for alignment of the trace or display with the horizontal graticule lines.

SCALE ILLUM

Control for varying the illumination of the graticule markings.

INTENSITY

Controls brightness of the display.

FOCUS

Permits adjusting the beam to obtain a well-defined display.

### HORIZONTAL Controls

POSITION

A ten-turn control to position the display horizontally.

DISPLAY

The DISPLAY switch selects the following eight displays: 2 field, 2 line, 1 line, 10 μs/cm, 5 μs/cm, and three line selector positions (10 μs/cm, 5 μs/cm, and 1 line).

The 2 FIELD, 2 LINE or 1 LINE positions of the DISPLAY switch are used for general waveform monitoring. When the DISPLAY switch is set to 2 FIELD, the sweep operates at the frame rate, displaying about 2 fields. The FIELD lever is used in conjunction with the 2 FIELD position to allow display of either field 1-EVEN or field 2-ODD. When the DISPLAY switch is set to 2 LINE, the sweep operates at one-third of the line rate, displaying about 2 lines. When the DISPLAY switch is set to 1 LINE, the sweep operates at one-sixth of the line rate, displaying about 1 line.

NOTE

**The 2 FIELD position is the only position of the DISPLAY switch where a free-running trace can be obtained in the absence of a trigger signal. Thus, the 2 FIELD position is useful for determining whether the video signal is absent.**

When the DISPLAY switch is set to 10 μs/cm or 5 μs/cm, horizontal timing is measured in terms of time per centimeter with no direct relationship to a video signal. Table 2-1 lists the actual time per centimeter at the different MAGNIFIER switch settings.

**TABLE 2-1**

| MAGNIFIER Setting | DISPLAY Switch Setting | |
|---|---|---|
| | 10 μs/CM | 5 μs/CM |
| ×1 | 10 μs/cm | 5 μs/cm |
| ×5 | 2 μs/cm | 1 μs/cm |
| ×10 | 1 μs/cm | 0.5 μs/cm |
| ×20 | 0.5 μs/cm | 0.25 μs/cm |
| ×25 | 0.1 μs/cm | 0.05 μs/cm |

When the DISPLAY switch is set to one of the LINE SELECTOR positions and the LINE SELECTOR control is used, it is possible to range into the top of the picture to examine any one or two lines, depending on the DISPLAY switch position. The LINE SELECTOR control can be set so the portion of the vertical blanking pulse which may contain vertical-interval

test signals can be examined in detail. This is particularly useful for observing $\sin^2$ (sine-squared) pulse and bar signals.

The range of the LINE SELECTOR control is such that any portion of field 1-EVEN or field 2-ODD can be examined. Either field 1-EVEN or field 2-ODD is selected by means of the FIELD switch. A special bright-up circuit in the Type RM529 MOD 188D increases the CRT writing rate in any of the LINE SELECTOR positions.

LINE & FIELD RATE

Four-position switch to select the line and field to match the television system (405/50, 525/60, 625/50, or 819/50) to be viewed. The switch changes the sweep timing components of the DISPLAY switch 2 FIELD, 2 LINE and 1 LINE positions and lights a front-panel indicator to show the line and field rate for which the Type RM529 MOD 188D is calibrated.

MAGNIFIER

Five-position switch to select sweep magnification ratios of ×1, ×5, ×10, ×20 and ×25 for all positions of the DISPLAY switch.

VARIABLE (MAGNIFIER)

Variable control with a range of +20% and −20% with respect to the MAGNIFIER switch setting. When the VARIABLE control is set to CALIB, the CALIB neon lamp turns on to provide a visual indication that this is the calibrated magnifier setting.

LINE SELECTOR and VARIABLE (LINE SELECTOR)[1]

Ten-turn variable control and a seven position switch, for starting the sweep at the beginning of any selected line in the field so that a particular line can be examined in detail. Used in conjunction with all positions of the MAGNIFIER and FIELD switches when the DISPLAY switch is set to a LINE SELECTOR position.

PAL FRAME SELECTOR

The PAL FRAME SELECTOR switch is a three-position switch having its front panel markings color coded blue to indicate use with the 625/50 television system only. Either extreme position of the switch selects a display of fields or lines from only one frame of the two frame cycle of the PAL (Phase Alternating Line) television system. The middle or NORM position of the switch displays every frame.

FIELD[2]

Two-position level switch to select either field 1-EVEN or field 2-ODD. Used in conjunction with the LINE SELECTOR and 2 FIELD positions of the DISPLAY switch.

SYNC

Two-position lever switch to select either internal or external sync sources.

[1]**Discrete line selection provided for 525/60 and 625/50 television systems only. For 405/50 and 819/50 television systems only the variable method of line selection can be used.**

[2]**A positive field selection is provided except for the French 819/50 television system.**

## REAR-PANEL CABLE CONNECTIONS

VIDEO INPUTS A, VIDEO INPUTS B

Two pairs of signal-input coaxial connectors are provided. These are VIDEO INPUTS A and VIDEO INPUTS B. These video inputs are designed for high-impedance loop-through, compensated for 75-ohm systems. Bridging capacitance is approximately 20 pF.

If the second connector of each pair is not used, it can either remain unused, or it can be used for terminating the line with a 75-ohm termination.

EXT NEG SYNC INPUT

A pair of coaxial connectors marked EXT NEG SYNC INPUT is provided on the rear panel to couple external sync signals to the Type RM529 MOD 188D. This input is a high-impedance loop-through connector and is compensated for 75-ohm systems. Bridging capacitance is about 20 pF. To select external sync, set the SYNC switch to the EXT position.

EXT CAL INPUT

The pair of connectors marked EXT CAL INPUT, located on the rear panel, is provided to couple external calibration signals to the instrument. The connectors are connected in parallel to couple the signal in and out of the instrument. To select the external calibration signal, set the INPUT switch to CAL and the CALIBRATOR switch to EXT.

VIDEO OUTPUT

A single VIDEO OUTPUT connector is provided for driving a picture or line monitor. It is important that the VIDEO OUTPUT connector be terminated into 75 ohms to ensure correct frequency response of the vertical amplifier. When properly terminated, the signal available at this connector is approximately the same amplitude as the signal applied to the Type RM529 MOD 188D.

Added to the VIDEO OUTPUT signal is a line intensifying pulse. This pulse is approximately 0.1 volt in amplitude or about 10% of the VIDEO OUTPUT signal when the input video signal is 1 volt.

The line intensifying pulse is generated only when the DISPLAY switch is set to a LINE SELECTOR position. The LINE SELECTOR control is used to select the line(s) on the picture monitor for easy identification.

J501 Connector

A 9-pin female connector (J501) is provided to connect an external staircase signal to the Type RM529 MOD 188D. Fig. 2-2 shows how to connect the signal and remotely actuate relay K501.

When K501 is actuated and the DISPLAY switch is set to any position, the sweep length is reduced to about 3 cm for a 3-step (RGB) display and to 2½ cm for a 4-step (YRGB) display. Sweep length is selected by an internal selector SW510. Thus, when a 20-Hz staircase signal of correct amplitude (about 12 volts overall amplitude) is applied through pin C of J501, the display is positioned in accordance with the staircase output from a color processor.

## FIRST-TIME OPERATION

NOTE

It is necessary to check and adjust the front-panel GAIN control each time the type of graticule is changed.

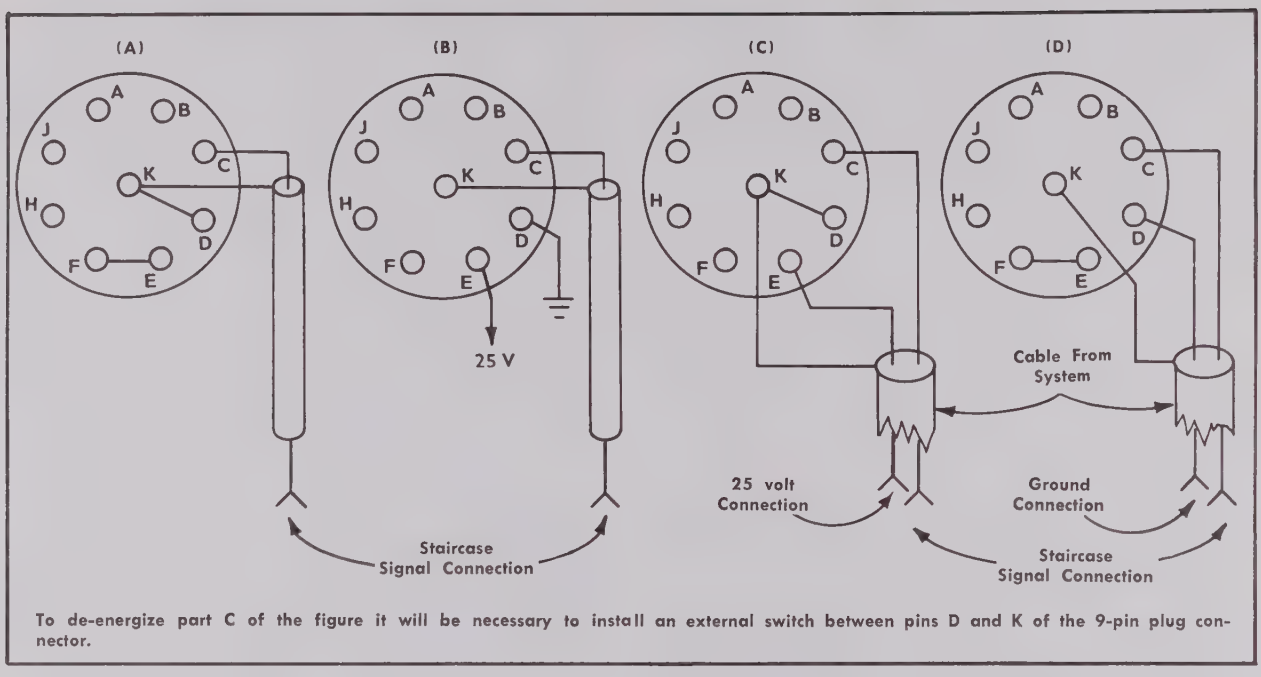



**Fig. 2-2. Front view of 9-pin plug connector. (Tektronix Part No. 134-0049-00) showing jumper wire connections to: (A) Cause relay K501 to be energized whenever the plug is in place. (B) Energize the relay when an external voltage and ground connection is used. (C) Energize the relay when a GE system is connected. (D) Energize the relay when a RCA system is connected.**

To place the instrument in operation for the first time, the following procedure is suggested:

1. Connect the instrument to a source of power specified by the metal tag located near the power connector.

2. Set the front-panel controls as follows:

| | |
|---|---|
| POWER | ON |
| TRACE ROTATION | As is |
| SCALE ILLUM | 2/3 clockwise |
| INTENSITY | 2/3 rotation clockwise |
| FOCUS | Centered |
| **VERTICAL Controls** | |
| INPUT | CAL |
| POSITION | Centered |
| RESPONSE | FLAT |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| GAIN | As is |
| DC RESTORER | ON |
| CALIBRATOR | FULL SCALE |
| **HORIZONTAL Controls** | |
| POSITION | Centered (five full turns from either end) |
| DISPLAY | 2 LINE |
| LINE & FIELD RATE | Set to system being used |
| MAGNIFIER | ×1 |
| VARIABLE (MAGNIFIER) | CALIB |
| LINE SELECTOR | As is |
| FIELD | 1-EVEN or 2-ODD |
| PAL FRAME SELECTOR | NORM |
| SYNC | INT |

3. After the instrument has warmed up for a few minutes, adjust the INTENSITY control for adequate brightness of the square-wave calibrator waveform.

4. Adjust the (VERTICAL) POSITION control to center the display.

5. Adjust the FOCUS control to obtain a sharply defined display.

6. To observe other waveforms, connect a video signal to either the VIDEO INPUTS A or B connector and set the INPUT switch to the appropriate position.

To observe an external calibration waveform, connect the calibration signal from the external source to the EXT CAL connector. Place the INPUT switch to CAL and set the CALIBRATOR switch to EXT.

## CRT Beam Rotator

If the trace does not coincide with the graticule lines, the TRACE ROTATION needs to be adjusted. To adjust the control, proceed as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

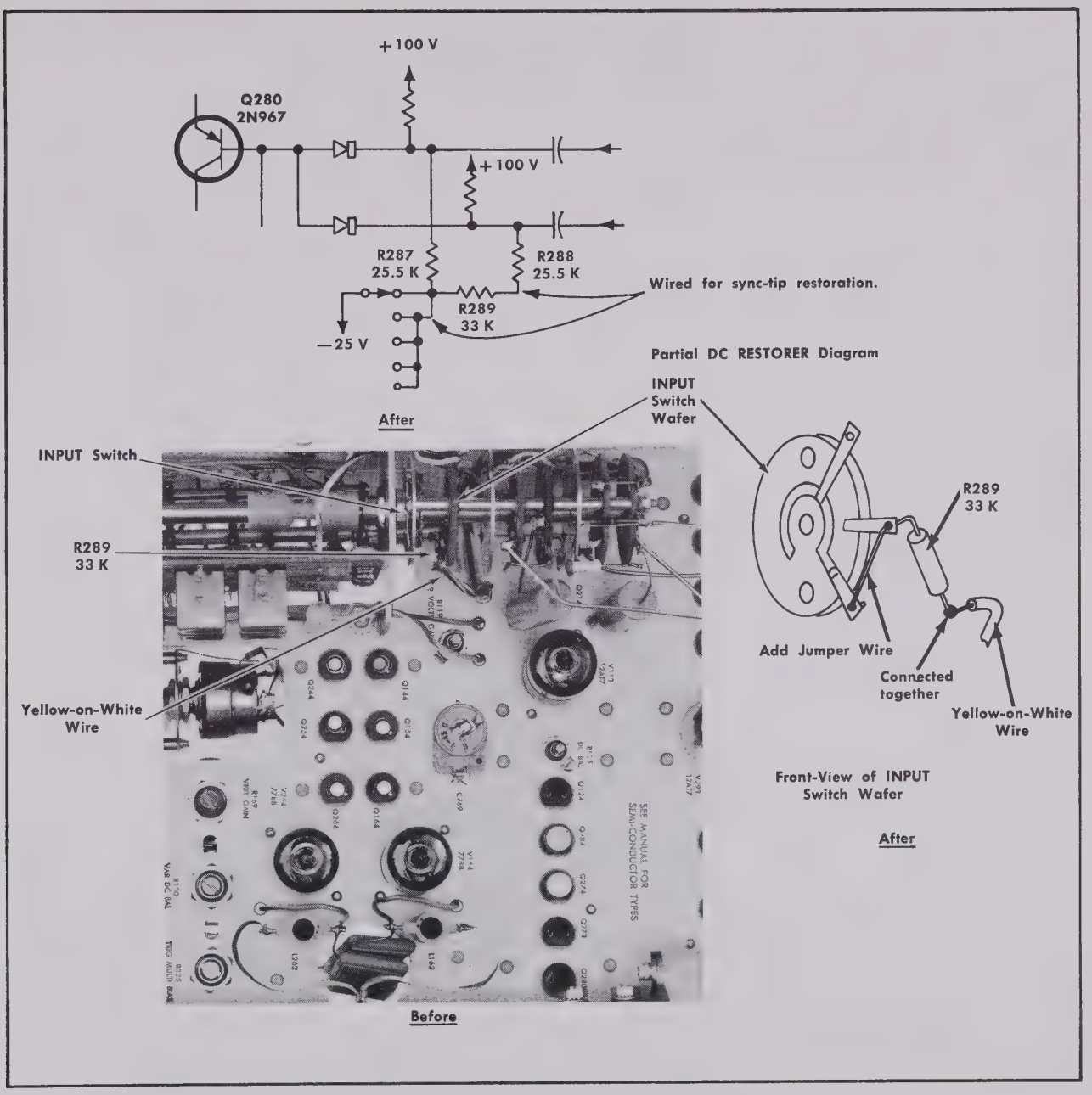



Fig. 2-3. Modification for sync-tip restoration.

2. Set the CALIBRATOR switch to .714 F.S., and the DISPLAY switch to 2 FIELD.

3. Adjust the TRACE ROTATION control so the bottom trace of the calibrator pulses are parallel to the horizontal graticule lines.

## GAIN Adjustment

A front-panel GAIN screwdriver adjustment is provided to correct for any change in the vertical gain.

Check vertical-amplifier calibration as follows:

1. Perform steps 1 through 5 in the First-Time Operation procedure.

2. Check that vertical deflection is correct amount for input signal. If the deflection is not correct, adjust the GAIN control to obtain proper deflection.

## MODIFICATIONS

1. Changing to Sync-Tip Restoration

To change the Type RM529 MOD 188D circuitry so sync-tip restoration can be used instead of back-porch clamping:

a. Unsolder the yellow-on-white wire (refer to Fig. 2-3) and R289 from the INPUT switch contact. Leave the wire and resistor leads connected together.

b. Solder a jumper wire between the two contacts on wafer 1F of the INPUT switch as shown in Fig. 2-3.

## NOTES

# SECTION 3
# CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

## General Information

The Type RM529 MOD 188D Waveform Monitor circuits contain both vacuum tubes and transistors. Portions of both the vertical and horizontal systems contain amplifiers with special feedback to make gain stability independent of tubes or transistors. Several multivibrators in the trigger and horizontal systems provide precise display triggering. Refer to the block and circuit diagrams at the back of this manual during the following circuit descriptions.

All connectors are rear-panel mounted. Four of the input circuits are 75-ohm coaxial loop-through; two VIDEO INPUTS, EXT NEG SYNC INPUT and EXT CAL INPUT. The Staircase Input (J501) is a special nine-pin socket (see Staircase Input discussion in Section 2 for mating connector). The VIDEO OUTPUT coaxial jack has a 75-ohm unbalanced output impedance.

## BLOCK DIAGRAM

The (VERTICAL) INPUT switch (see block diagram at the rear of the manual) selects one of five signal inputs to be applied to the preamplifier. The five signal sources are A-AC coupled, A-DC coupled, B-AC coupled, A-B, and CALIBRATOR (the calibrator signal can be from an external source). The preamplifier and magnifier supplies the selected signal to both the response filters and the sync amplifier. The response filters pass the signal on to the output amplifier and to the CRT deflection plates. The output amplifier also supplies the signal to the keyed DC restorer circuit. The sync amplifier supplies an AC-coupled signal to the VIDEO OUTPUT jack (with an open circuit gain of 2, or a 75-ohm loaded gain of 1 referred to the video input) and to the sync separator.

The sync separator regenerates the sync pulses so their shape and amplitude is always the same. Plus and minus regenerated (Horizontal sync) pulses are available for operating the keyed DC restorer circuit. Minus H pulses are used when displaying video, and plus H pulses are used when displaying the calibrator.

The keyed DC restorer circuit holds the display at the video back-porch level or the negative level of the internal calibrator. The circuit operates by controlling the DC level of the preamplifier and magnifier minus input. The video input signals are AC coupled, but the preamplifier and magnifier, response filters, and output amplifier are DC coupled. The DC-restorer circuit virtually eliminates display shift with change in signal amplitude, but response time is slow enough for hum or tilt to be observed.

The sync separator —H signal is used by the trigger selector matrix when the display is of a line nature (undelayed). The +H signal does not go direcly to the trigger selector matrix, but to the vertical sync separator, and then to both the field 1 recongnition circuit and the field trigger generator (Q375-Q385). The field trigger generator triggers the sweep gating multivibrator via the trigger selector matrix for field displays (undelayed) and triggers the sweep gating multivibrator through the delay generator and trigger selector matrix for delayed field displays.

The sweep gating multivibrator and sweep generator triggering source and sweep rate is set by the front-panel DISPLAY switch. Triggers are received by the sweep gating multivibrator, which allows the sweep generator to run and drives the unblanking amplifier to turn on the CRT beam at the time of the sweep. The unblanking amplifier also sends a brightening pulse to the CRT and the VIDEO OUTPUT jack during delayed line modes. The sweep generator drives the horizontal amplifier. The staircase amplifier also drives the horizontal amplifier but only when external control (through J501) switches the sweep generator function to read the red, blue, green (RGB) or red blue, green and black-white (YRGB) portions of a color studio camera.

The high voltage supply contains the CRT high-voltage power supply. A portion of the power-supply circuit forms the calibration signal at the $\simeq$ 30 kHz rate of the high-voltage oscillator. An external calibrator signal can be substituted for the internal signal.

## CIRCUIT DESCRIPTION

### Vertical Amplifier

The video input circuits of the vertical amplifier are shown in simplified form in Fig. 3-1. The 10-ohm resistor in Fig. 3-1A is optional, but necessary in the event there is any AC potential difference between the input coaxial and the Type RM529 MOD 188D chassis. It presents any cable-to-chassis signal differentially to the vertical amplifier so the signal will not become part of the display. (Any signal on the outside of the braid of a coaxial cable is also on the center conductor, but with the same polarity. The equal signals are applied to the + and — input terminals, and are cancelled by the differential rejection characteristics of the vertical amplifier.) The A-B input of Fig. 3-1B does not use the 10-ohm resistors because the cables are likely to have the same unwanted information. Since the unwanted information appears on both center conductors, it is presented to the vertical amplifier in differential form and is cancelled.

**Operating With the DC Restorer Circuit Off.** Operation of the vertical amplifier will be described first with the DC restorer circuit turned off.

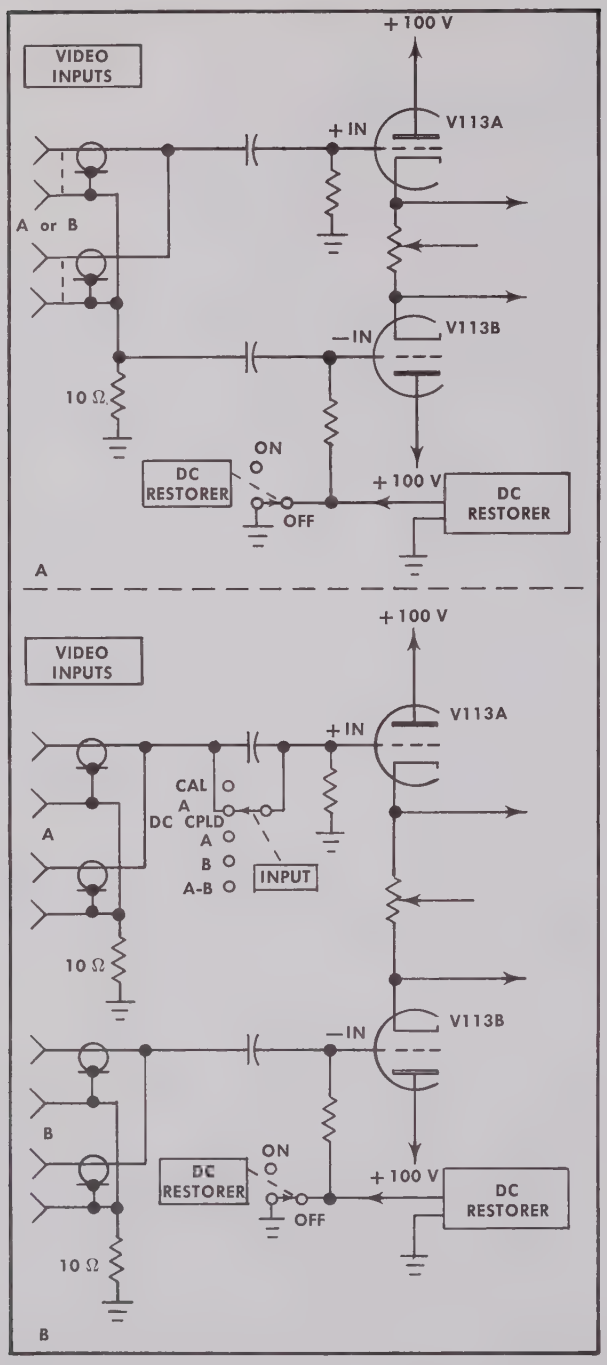



**Fig. 3-1. Simplified vertical amplifier input circuits.**

The input signals are normally AC coupled, however, channel A maybe DC coupled to both the + and — input grids of V113 and, through C104 and C204, see a 1 megohm return to ground. The rest of the vertical amplifier is DC coupled.

**Preamplifier.** The preamplifier consists of two input cathode followers (V113A and V113B), and two transistor amplifiers (Q114 and Q214). The preamplifier is shown in simplified form in Fig. 3-2A. The cathodes of V113 return to the same constant-current circuit to which emitters of Q114-Q214 return. The VOLTS FULL SCALE control between emitters of Q114-Q214 couples the signal between emitters, causing both sides of the amplifier to have on output signal when either input receives a signal.

The tubes serve basically as impedance transformers, changing the 1-megohm input resistance to about 400 ohms to drive the transistor bases. The cathode-return resistors have a value about 20 times the cathode-follower output impedance; they do not attenuate the signal significantly. Each cathode follower passes about 93% of the input signal to the following transistor base.

The emitter resistors would normally cause considerable degenerative effect, and would thus keep the stage gain very low. However, the VOLTS FULL SCALE resistance between the two emitters also couples the signal from one side to the other. Fig. 3-2B shows a simplified concept of the VOLTS FULL SCALE control signal path. If, in this theoretical circuit, the VOLTS FULL SCALE resistor were made zero ohms, the input signal to one transistor base would divide equally between the two halves of the stage. Fig. 3-2B shows the internal emitter resistance in series. Thus, VOLTS FULL SCALE equal to zero ohms degeneration on one side of the amplifier is the emitter resistance of the other side. This causes both sides of the amplifier to have gain. The emitter return resistors are many times greater than the emitter internal resistance, and, therefore, do not attenuate the signal when the VOLTS FULL SCALE resistance is low. The actual minimum VOLTS FULL SCALE resistance is about 590 to 600 ohms between emitters setting the push-pull output signal equal to about 2 times the single-ended input signal.

A typical single input signal will cause the following action (assume the VOLTS FULL SCALE resistance to be 600 ohms): Q114 base is driven in the positive direction 1 volt and its emitter follows it nearly 1 volt. The 600-ohm resistor allows the emitter current to increase and the emitter voltage to follow the base voltage nearly one volt. The increased forward bias of Q114 is about 0.02 volt. The signal current is essentially 1.66 mA greater than the static current. The only source for the signal current is the emitter Q214; therefore, both transistors receive the same amount of signal current (but of opposite polarity) for a single input signal. The result is that both collector resistors have a 1.66 mA signal current. The collector of Q114 goes negative, and the collector of Q214 goes positive producing a push-pull output signal about 2.2 volts peak to peak. Since the collector load resistors have equal and opposite current changes, the voltage at their center does not change. Except for presence of the constant current stage, common-mode signals reaching the preamplifier would change the voltage at the junction of the collector load resistors, and degrade the commond-mode rejection of the amplifier.

The high-frequency gain of the preamplifier is adjusted to equal the low-frequency gain by making the RC time constant of the emitter circuit equal to the RC time constant of the collector circuit. The cathode followers' output impedance allows the Miller capacitance of the transistors to affect the high-frequency response. To minimize the Miller effect, the transistor stage is neutralized by C113 and C213. The variable capacitors (C118B and C118C) across the VOLTS FULL SCALE resistors R118B and R118C permit the preamplifier frequency response to be properly adjusted. There is no need for a variable capacitor across R118A, due to wiring stray capacitance.

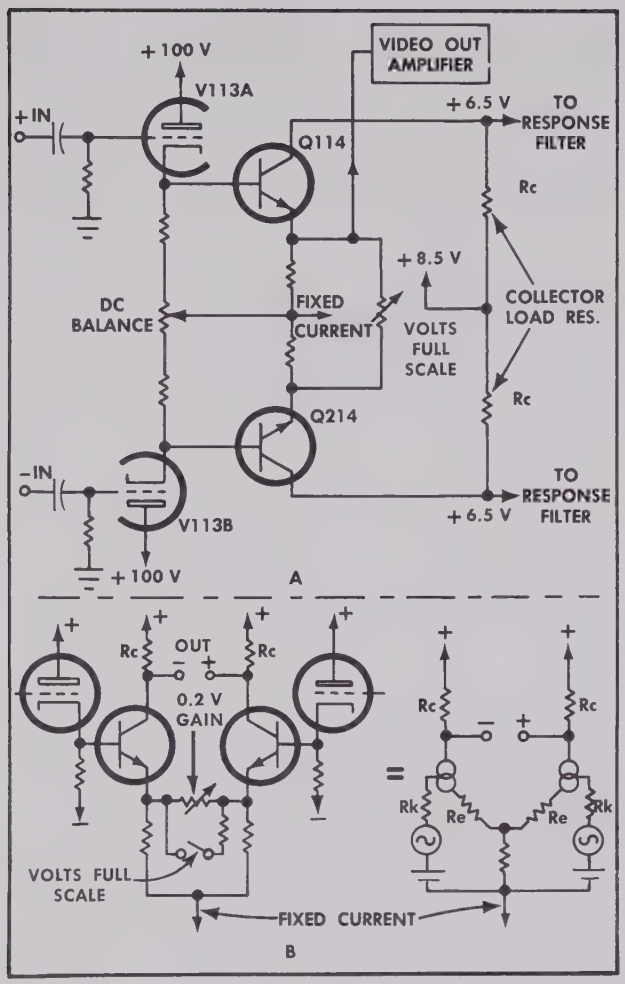



Fig. 3-2. Simplified circuit.

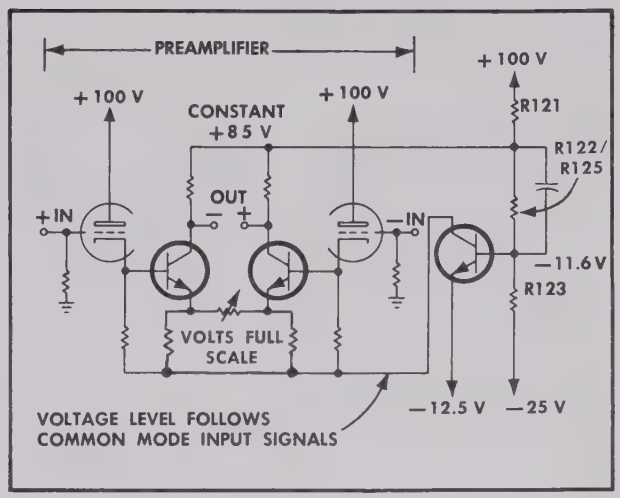



Fig. 3-3. Simplified constant current stage connections on preamplifier.

In the event of minor differences in bias of the input cathode followers (with resultant output voltage difference), DC BAL control R115 is set to create a compensating change in current in the cathode return circuit. The DC BAL control final setting is correct if the trace does not shift when changing the VOLTS FULL SCALE switch position (with the DC RESTORER OFF).

The high impedance of the preamplifier transistor collectors allows the output voltage to be varied in slight amount without significant change in current. The VAR DC BAL control slightly alters the voltage balance of the preamplifier output to allow the output amplifier VARIABLE control (between emitters of Q144-Q244) to be adjusted without shifting the trace position.

**Constant Current Stage.** The constant current stage cancels any push-pull output from the preamplifier in the event both input leads receive equal amplitude-equal polarity signals. The circuit causes the voltage of the constant current leads of Fig. 3-2 to shift and follow any common-mode input voltages. (The high collector resistance of Q114 and Q214 prevents any change in the preamplifier output voltage.) Fig. 3-3 shows simplified connections between the constant current stage and the preamplifier. Assume both input leads to be positive. The result is that both collector-load resistors receive an increase in current. The increased current pulls down on R121. R122 and R125 divides the change to the base of Q124. Q124 base goes negative and causes its collector to go positive an amount equal to the original common-mode signal. This cancels its effect and returns the current in the collector-load resistors to the original value. The input cathode followers negative supply is the same as Q114-Q214 negative supply, to ensure signal linearity in the event of common-mode signal cancellation by Q124.

The principal reason for keeping the common-mode currents out of the preamplifier is that even through the currents may be equal, the collector load resistors may not be precisely equal, and equal currents would generate unequal output voltages. The circuit does stop the preamplifier output from moving positive or negative with common-mode signals.

**Response Filters.** The frequency response of the overall monitor is altered for special purposes by the RESPONSE switch and its filters.

The FLAT position of the RESPONSE switch gives the widest bandwidth, with a direct connection from the preamplifier to the output amplifier.

The IRE position of the RESPONSE switch inserts components that cause the overall monitor bandwidth to be low-pass to agree with 1958 Standard 23S-1.

The LOW PASS position of the RESPONSE switch inserts components that alter the overall response so that it is about 12-dB down at 500 kHz.

The 1.10 MHz position of the RESPONSE switch inserts components making the overall monitor bandpass about 400 kHz centered at 1.10 MHz. The DC level at the input of the output amplifier is maintained by connecting the center (AC ground point) of L136 to the junction of R122 and R125.

The 3.58 MHz position of the RESPONSE switch inserts components making the overall monitor bandpass about 800 kHz

centered at 3.58 MHz. The DC level at the input of the output amplifier is maintained by connecting the center (AC ground point) of L139 to the junction of R122 and R125.

The 4.43 MHz position of the RESPONSE switch inserts components making the overall monitor bandpass about 1.2 MHz centered at4.43 MHz. The DC level at the input of the output amplifier is maintained by connecting the center (AC ground point) of L134B to the junction of R122 and R125.

**Output Amplifier.** The output amplifier includes two sets of push-pull amplifiers, each with variable emitter coupling to vary the gain. The first amplifier is Q144-Q154 and Q244-Q254. The second amplifier is driven by the first, and is a combination of transistors and tubes giving a large voltage output swing.

The driver portion of the amplifier has negative feedback from the collector of Q154 to the emitter of Q144 (and from Q254 and Q244). The negative feedback makes the input impedance at the base of Q244 very high and the output impedance at the collector of Q154 quite low. The high input impedance prevents loading of the response filters. The low output impedance is needed to drive the base of Q164 (and Q264). R154 is the negative feedback path and is also the collector load resistor for Q154 (see Fig. 3-4).

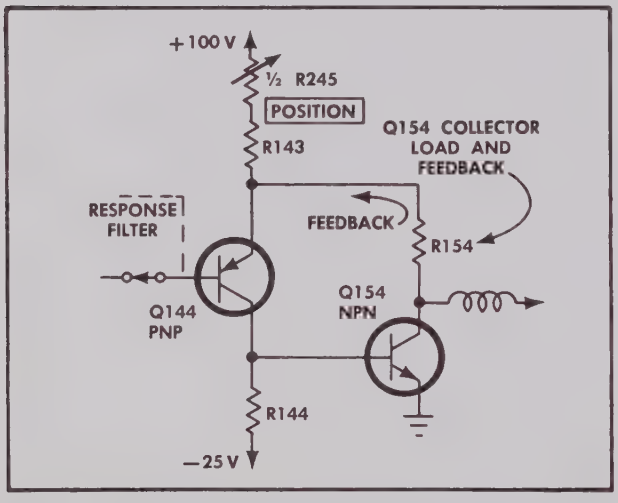



**Fig. 3-4. Simplified one-half output driver stage.**

The VARIABLE gain control (concentric with the VOLTS FULL SCALE switch) varies the emitter-to-ground degeneration between Q144 and Q244 to vary the overall vertical amplifier gain by a 2.5:1 ratio. The VARIABLE control mechanically switches R241 into the circuit in the CALIB position, and out of the circuit (SW240 closed) when not in the CALIB position. If the VARIABLE control is counterclockwise at lower than calibrated gain, clockwise rotation can increase the monitor gain so it is greater than normal. Then, as the clockwise end of rotation is reached and the control is rotated to snap into the CALIB position, the overall gain drops about 70% as R241 is switched into the circuit. At the same time a second part of SW240 closes and turns on the front-panel CALIB neon lamp.

The output driver signal is coupled to the base of Q164 (Q264) of the output cascode amplifier. The combination of a transistor (supplying cathode drive) and a tube not only gives stable gain but also gives the wide voltage output swing. The output cascode stage also has emitter- to-emitter degeneration used to adjust the overall vertical amplifier gain to match the CRT deflection factor. The emitter circuit also contains the HF COMP capacitors that permit the output stage high-frequency gain to be adjusted a bit higher than the low-frequency gain. This adjustment helps make the bandpass correct for the FLAT position of the RESPONSE switch.

While reading the following description of the cascode stage operation, keep in mind that (1) a transistor's emitter follows its base, just as a tube's cathode follows its grid-if the return circuit is a higher impedance than the internal emitter or cathode impedance, and (2) a transistor's collector has quite a high impedance, as high as the plate impedance of some triode tubes.

A signal that drives the base of Q164 in the positive direction causes several simultaneous circuit changes. The emitter voltage of Q164 follows the base voltage (with emitter voltage change about 2 percent less than base voltage change) offset by normal silicon transistor bias. The positive swing of Q164 base drives the grid voltage of V164 positive the same amount and the cathode of V164 follows, lagging its grid about 20 percent. The 20 percent positive bias occuring in V164 as a result of cathode-follower action increases plate current and the consequent plate current increase causes the output plate voltage to drop in the negative direction an amount determined by R162 and Ohm's Law.

Push-pull signals that drive the bases of Q164-Q264 drive the two halves of the output stages equally. (The degenerative action of the resistors between emitters is one half what it would be if only one base received a signal.) The signal voltages at Q164-Q264 bases cause plate-current changes of V164 and V264 to be about 3.3 mA per centimeter of spot deflection each, producing a push-pull voltage output to the CRT deflection plates of about 20 volts per centimeter. The peaking coils in each plate circuit compensate for deflection-plate capacitance, and aid in obtaining flat frequency response of the vertical amplifier. The screen grids of V164 and V264 are current limited by R161 and D161.

Positioning the CRT display (with DC RESTORER OFF) is by current injection into the emitter circuits of Q144-Q244 through R143 and R243. The POSITION control (R245) sends current toward the cascode output stage bases, but this current does not affect the display position so long as the DC restorer is off. Voltage changes at the bases of Q164 and Q264 do not significantly affect the positioning circuit because of two germanium diodes, D271-D272, which limit the voltage difference between R149-R249 junctions with R148-R248. The two diodes appear on the DC restorer diagram.

With DC RESTORER on, the DC restorer circuit provides an automatic DC positioning voltage to the —input grid of V113B. The source of DC positioning voltage is the signal in the base circuit of the output cascode stage. The signal is usually composite video (sometimes it is the calibrator). The DC restorer circuit positions the CRT display firmly around the level of the composite video horizontal sync pulse back porch. Because of these facts, the restorer must look at the video only at the correct time. The DC restorer circuit is keyed by the horizontal trigger system to sample the video back porch for about 0.4 $\mu$s, and remember the DC level until the next horizontal sync pulse occurs.

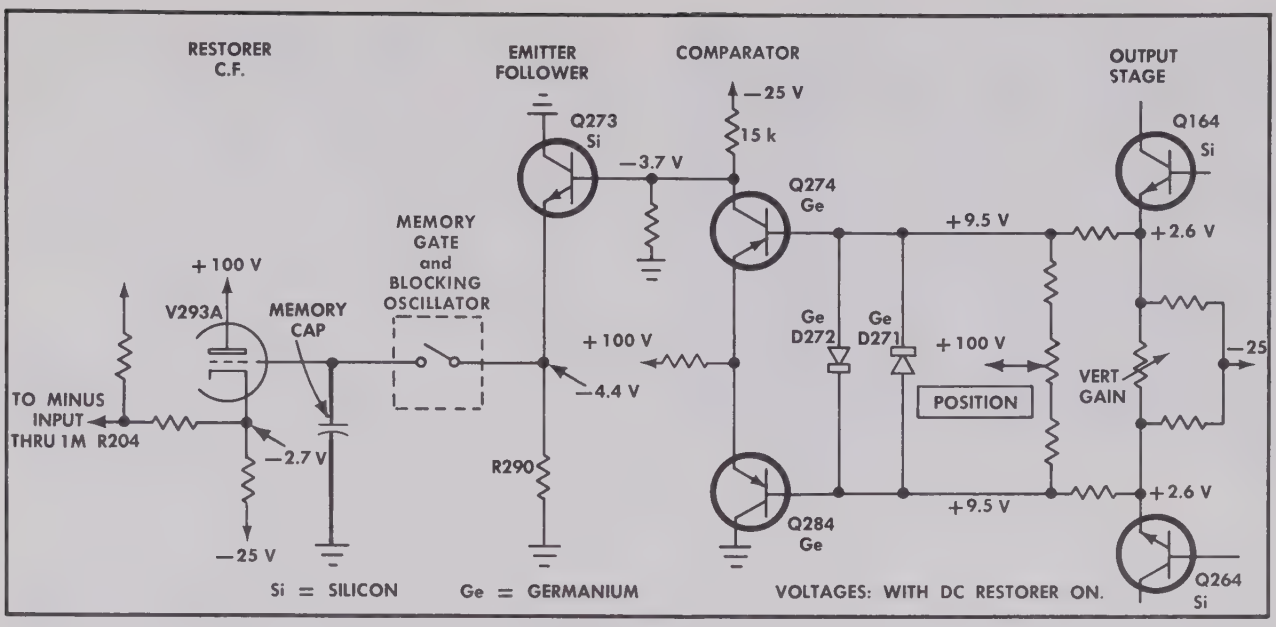



Fig. 3-5. Simplified keyed DC Restorer circuit.

**Video Output Amplifier.** The video output amplifier receives its signal from the emitter of Q114. The input impedance of Q174 is greater than 50 kΩ due to the large amount of emitter degeneration, which loads Q114 lightly. Q174 produces an inverted current drive to the feedback amplifier Q184-Q194 of essentially 1 mA per 1 volt. The emitter impedance of Q174 is R172-R173 in parallel, or 1.06 kΩ. Since the collector current of Q174 changes linearly with base-voltage drive, the signal-source resistance of Q184 base is 1.05 kΩ. Then, the voltage gain of Q184-Q193 (set by the feedback resistance divided by the input resistance) is $\frac{2.2\ k\Omega}{1.06\ k\Omega}$ or about 2.06. Assuming 3% signal loss in the preamplifier, the gain from input to Q103 collector is 2. R198 in series with a 75-ohm load makes the overall gain 1. The feedback (R192) makes the video output amplifier have a very low output impedance. Thus, the amplifier is matched to the output coaxial line by inserting a series 75-ohm resistor (R198). The reactance of C198 is so low at the frequencies passed by the circuit that it does not increase the output resistance over that of R198. R199 ensures that C198 is properly charged.

The video output amplifier also serves as an internal trigger amplifier. The output lead to the sync clamping amplifier (diagrammed with the sync separator) rests at —5 volts.

The sweep generator applies a positive pulse to the video output jack when operating in a line selector mode. The intensifying pulse amplitude is about 0.2 volt at the video output jack (0.1 volt when loaded with 75 ohms). The value of the pulse is set by current from a +100-volt pulse in the sweep generator unblanking circuit applied through R476 (diagrammed near the unblanking amplifier with the sweep generator) to the 75-ohm output resistor R198. The very low output impedance of the video output amplifier prevents the intensifying pulse from disturbing the internal triggering signal.

## Keyed DC Restorer

The Keyed DC Restorer circuit includes the DC restored comparator, the blocking oscillator, and the restorer cathode follower. Voltages and waveforms on the DC restorer diagram were taken with the DC restorer circuit on. The simplified diagrams of Fig. 3-5, 3-7, and 3-8, and waveforms of Fig. 3-6 will help during the following discussion of the DC restorer circuit operation.

The DC restorer comparator is a dual-input signal, output amplifier that amplifies a small part of the composite video which is normally near the CRT screen center. The signal peaks are limited by parallel back-to-back germanium diodes D271-D272 (see Fig. 3-5). One of the two diodes conducts whenever the voltage across them exceeds 0.2 to 0.3 volt. When the signal at the base of Q274 goes negative (and the signal at the base of Q284 goes positive) D271 conducts. The opposite polarity signal causes D272 to conduct. The peak-to-peak signal input to the comparator is, therefore, limited to about 0.45 volt. The comparator output signal is typically 4.2 volts peak-to-peak at the emitter of the emitter follower (Q273). The comparator functions in the same manner as the differential preamplifier previously described, except there is just one output lead. Fig. 3-6 shows the signal as it enters the memory gate. The other waveforms of Fig. 3-6 are discussed with the blocking oscillator below. Burst is removed from the output signal of the comparator by the filter action of L274, C274 and C275.

**Blocking Oscillator.** The blocking oscillator is normally biased to cutoff by current through R282 and D282. A negative pulse applied to the base of Q280 will cause it to conduct and go through one cycle of oscillation. The negative pulse arrives at the base of Q280 through a diode switching network (D285 & D286) from the sync regenerator (diagrammed with the sync separator).

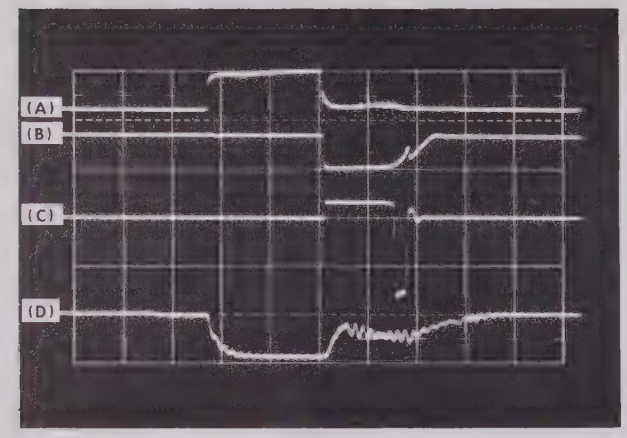



Fig. 3-6. Time-coincident waveforms of keyed DC Restorer.

Assume the vertical INPUT switch is at A, as shown in Fig. 3-7. The diode switching circuit then reverse biases D285 about 45 volts and reverse biases D286 about 1 volt. Regenerated horizontal sync pulses arriving at C285 and C286 have a peak-to-peak amplitude of about 8 volts. Thus, the —H pulse will not cause D285 to conduct, but the +H pulse will cause D286 to conduct at the end of the pulse as it goes negative. C286 charges almost the full 8 volts of the +H pulse rise, and then causes the cathode of D286 to fall about 7 volts. The base of Q280 does not fall as much as 8 volts because of the low base-to-emitter impedance at the time of turn on.

The blocking oscillator turns on at the time the composite video horizontal sync pulse ends and starts toward the back-porch level. The back-porch level occurs about 0.25 $\mu$s later, so the blocking oscillator does not sample the video at the time of turn-on. As Q280 conducts, the L/R time constant of the collector circuit inductance and resistance keeps Q280 conducting for about 3 $\mu$s before the base drive decays. As Q280 regenerative base turn-on drive is stopped, the collector current drops rapidly. Dropping collector current is transformer-coupled back to the base of Q280 as a fast turn-off signal. The collector voltage waveform is shown in Fig. 3-6. Changing collector current is also transformer-coupled to the tapped secondary that drives the memory gate.

**Memory Gate.** The memory gate consists of the center-tapped secondary of T280 with its DC level set by the emitter follower, two parallel RC circuits and two silicon diodes. As Q280 is turned on, the secondary voltage of T280 reverse biases D292 and D293 and no current flows. As Q280 stops conducting, the secondary voltage of T280 drives D292 and D293 into conduction and at the same time charges both C292 and C293 to about 7 volts. (The energy for charging the two capacitors comes from the core of T280.) D292 and D293 are diodes with equal forward drop at the time they conduct, making the voltage at their junction with C294 equal to the voltage at the center of T280 secondary. Thus, during the backswing time of T280, the voltage at the center of T280 secondary appears at C294. The backswing lasts for about 0.4 $\mu$s, which is plenty of time to fully charge C294 to the voltage of the emitter follower. During each backswing, C292 and C293 are recharged to replace the small amount of voltage discharged by the resistors R292 and R293. The time constant of the two RC circuits is 1 ms each, many times longer than the 63.5 $\mu$s between sampling times.

**Memory Circuit.** The memory circuit includes the memory capacitor C294 and the grid of V293A. Since D292-D293 are silicon diodes with very low reverse leakage, the memory capacitor charge is essentially constant between samples.

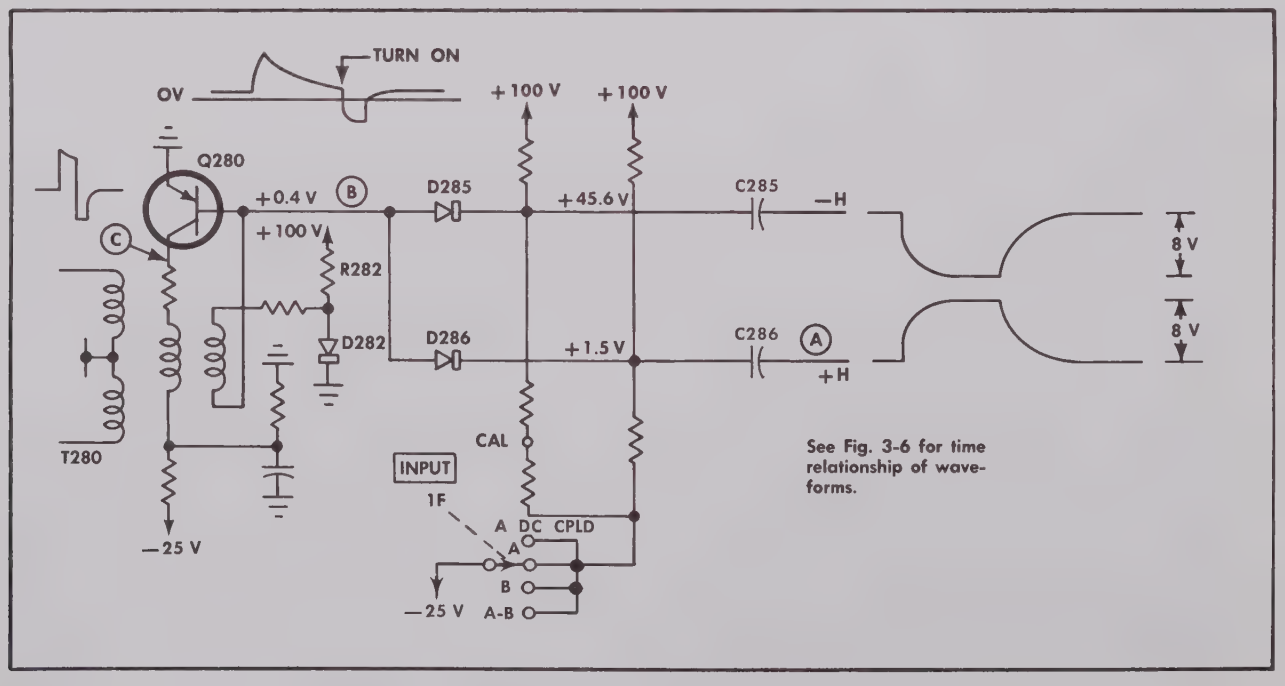



Fig. 3-7. Operation of Diode switch feeding Blocking Oscillator.

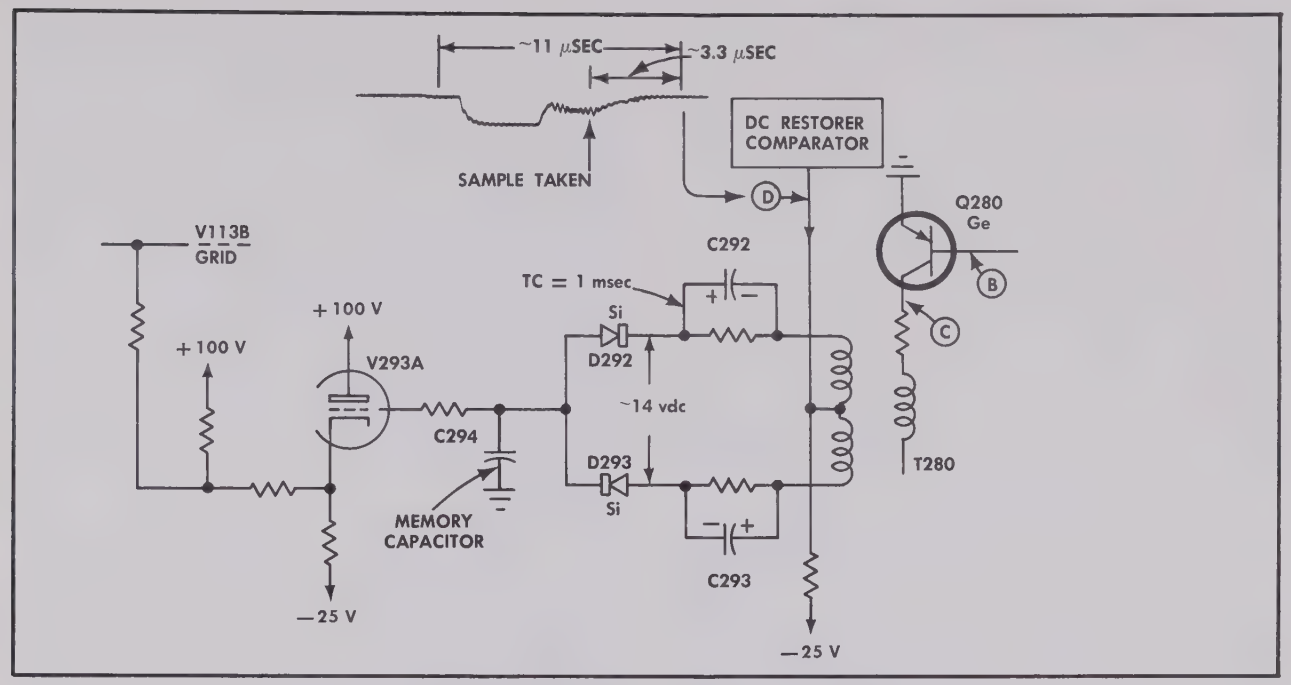



Fig. 3-8. Sampling and memory portions of DC Restorer circuit.

The four waveforms of Fig. 3-6 (taken with a four-channel oscilloscope) show the time-coincidence of the DC restorer circuit.

**Restorer Cathode Follower.** The restorer cathode follower acts as an impedance transformer that couples the sampled and stored voltage into the vertical amplifier minus input grid. The two resistors, R298 and R299, offset the DC level of V293A cathode to the correct value for the minus input, setting the minus grid to essentially ground voltage when the system is correctly balanced.

**Restorer Operation on Calibrator Signal.** This mode of restorer operation uses the —H regenerated horizontal sync pulse to fire the blocking oscillator. The —H signal starts negative at the same time the calibrator signal goes negative. The blocking oscillator fires as the —H signal goes negative, causing the DC restorer circuit to sample the signal voltage about 0.88 μs after the beginning of the calibrator negative half-cycle. Thus, the display is stabilized at the bottom of the calibrator signal and held in the same position as the back porch.

## Sync Separator

The sync separator processes composite video so the sweep generator is triggered properly for the various modes of the DISPLAY switch.

The input to the sync clamping amplifier can be from one of two sources; the internal trigger signal from the video output amplifier or an external sync input, usually composite video. The selection of source is made by the SYNC switch. Source switching is by diodes and the actual SYNC switch is isolated from the video leads by R305. When the SYNC switch is set to INT, D301 is back biased and D304 is forward biased. The signal passes through forward-biased D304 into the grid of V293B. When the SYNC switch is set to EXT, D304 is back biased and D301 is forward biased, so the signal passes through D301. The internal-external sync selection can be made from the front panel for all vertical input modes except when viewing the calibrator signal. When the vertical INPUT switch is at CAL, the sync input is automatically switched over to internal.

**Sync Clamping.** The sync clamping amplifier has two feedback loops. One is a normal type consisting of R315, with the gain of Q314 set by R315 and the transconductance of V293B.

A feedback amplifier of the type in the sync clamping amplifier, shown in Fig. 3-9, has a low input impedance, called virtual ground, and a low output impedance. The virtual ground is easy to visualize when we find equal and opposite currents in the input resistor ($R_i$) and the feedback resistor ($R_f$). Assume $R_f$ of Fig. 3-9 to be 22 kΩ and $R_i$ to also be 22 kΩ. A one-volt IN signal will cause 0.045 mA to flow in $R_i$. The transistor collector will change voltage level (also 1 volt) until an opposite 0.045 mA flows in $R_f$ at which time the input signal is balanced, so none is left for the base. When $R_i = R_f$ the voltage gain is unity ($A = \frac{R_f}{R_i}$).

V293B cathode output impedance is approximately equal to $\frac{1}{Gm}$ or typically $\frac{1}{0.001\ S^1} = 1000\ \Omega$ (Normal range of output resistance between tubes will be from about 600 to 1200 Ω). The cathode-follower output resistance can be considered directly in series with the input grid for calculating signal current to the base of Q314. Thus, the typical voltage gain of Q314 is $\frac{22\ k\Omega}{1\ k\Omega} = 22$.

[1]siemens = mho

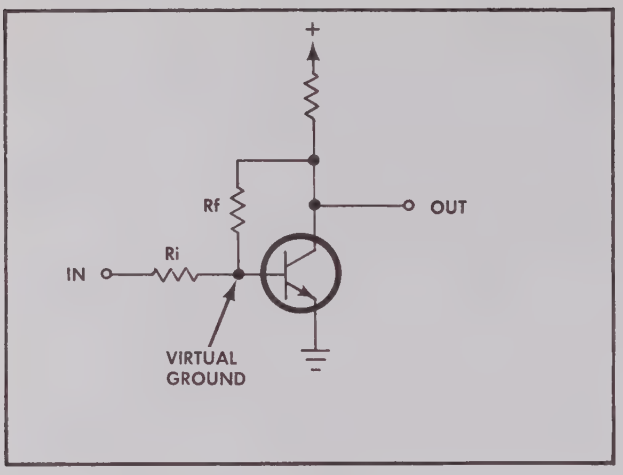



Fig. 3-9. Simplified Feedback amplifier.

A second feedback loop around the Sync Clamping Amplifier is composed of R317, R318 and C317. This loop acts as a DC restorer for signals into the rest of the triggering circuitry. Negative-going composite video at the grid of V293B causes the collector of Q314 to go positive. As each negative-going sync tip occurs, C304 charges slightly positive, then as the collector voltage of Q314 falls, C317 gains a negative charge that is the average of the input signal amplitude. C304 thus receives a charge as each sync tip occurs, then discharges through R317 to C317 at all other times. The discharge current for C304 is approximately proportional to video level. The effect of the action just described is that C304 acts as a DC restorer for the Sync Clamping Amplifier for a wide range of signal levels. Restorer action thus holds the Sync Clamping Amplifier output (at the sync pulse tips) at a stable level of about —0.5 volt.

Any large noise pulses riding on the negative-going composite video will cause the collector of Q314 to go positive enough to back bias D318; while at the same time, the large negative-going pulse at the grid of V293B will cause D317 to be forward biased. Forward biased D317 will now cause the charge rate of C304 to be limited by R319.

Video stripping occurs in the Sync Clamping Amplifier as the input signal goes positive, because available Q314 collector current through R314 is all taken by the feedback resistor R315. As V293B cathode applies positive-signal turn-off current to the base of Q314, Q314 collector goes negative until the current in R315 equals the current in from V293B cathode. At that point, the collector voltage stops going negative and the remaining positive signal input to V293B grid is not amplified. Thus, the DC-restored sync tips out of the Sync Clamping Amplifier have a maximum peak amplitude of about 13 volts with the video information removed from large signals.

**Sync Regenerator.** The Sync Regenerator is a Schmitt circuit whose operation is bistable due to the DC coupled input signal from Q314 collector. Q335 conducts when the base of Q325 is near ground, and Q325 conducts when the input is more negative than about —4 volts. Output signals are each about 8 or 9 volts peak to peak. The TRIG MULTI BIAS control is adjusted for proper triggering on low-level video sync signals in case the Sync Regenerator input signal is less than normal.

Assume Q325 is conducting. As the input signal goes positive, current in Q325 is reduced, allowing its emitter to go positive and its collector to go negative. Q325 emitter is coupled to Q335 emitter and Q325 collector is coupled to Q335 base. Initially the back bias at the base-emitter junction of Q335 prevents it from conducting. As Q335 bias reaches the point of conduction, regenerative action flips the conduction from Q325 to Q335 rapidly. As long as a sync tip holds the base of Q325 up near ground, Q335 will conduct. As Q325 base starts negative, Q325 begins to conduct and a second regenerative action switches Q335 off and Q325 on. The regenerative path is between the emitters of Q325-Q335 and from the collector of Q325 to the base of Q335.

Both the +H and —H signals are available for the keyed DC restorer circuit previously described, and for the rest of the triggering circuitry.

## Field Selector

The Field Selector circuit includes the Vertical Sync Separator, the Field 1 Recognition circuit, the Field Trigger Generator and PAL Frame Trigger Generator.

**Vertical Sync Separator.** The Vertical Sync Separator is primarily a differentiator and an amplifier biased off about 3 volts. The differentiator, C341-R341, shifts the signal output DC level depending on the pulse duty cycle. If the incoming square-wave signal negative peaks are of longer duration than the positive peaks, the output will be more positive than negative. Likewise, if the incoming signal positive peaks are of longer duration than the negative peaks (vertical sync), the output will be more negative than positive. During the time C341 receives only regenerated horizontal sync pulses, the signal at the base of Q344 shifts between about 2 volts negative and 6.5 volts positive and Q344 does not conduct. As the vertical sync group occurs, the signal at the base of Q344 shifts to between about 6 volts negative and 2.5 volts positive, turning Q344 on hard each time the signal goes below about —3.5 volts.

Both the Field 1 Recognition circuit and the Field Trigger Generator require a single pulse, the first of the vertical sync pulses. The parallel combination of R346-D346 and the capacitance of C347 allow only the first vertical pulse to pass through. As the first vertical pulse biases Q344 on, the collector of Q344 rises positive 20 volts and D346 passes the whole pulse to C347 (and C351). C347 charges to more than half the peak voltage of the first pulse. The very high reverse resistance of D346 and the resistance of R346 let C347 keep its charge. The second vertical sync pulse is not coupled through since the cathode of D346 is already several volts more positive than it was before the arrival of the first pulse. (Some of the second pulse gets through the coupling capacitors, but does not affect the following circuits.) R346 discharges C347 (and C351) before the next vertical pulse arrives.

**Field 1 Recognition.** The field 1 recognition circuit is a one-shot multivibrator (mono-stable) with two input paths. The single vertical sync pulse that arrives through C351 to the base of Q355 turns Q355 on and Q365 off. The switching action is regenerative due to emitter coupling, and coupling from Q355 collector to Q365 base. C360 was initially charged to about 13 volts. As Q355 collector falls, the base of Q365 is taken about 11 volts negative. The line

and field controls, selected by LINE & FIELD RATE switch SW480, (R360A, B, C or D) in series with either R362A, B, C or D and R359 and R361, starts the base of Q365 back toward ground, discharging C360. As the voltage at the base of Q365 nears a value that would cause Q365 to turn on, a positive pulse coupled to the base through C361 will turn it on and reset the multi. The time constant of C360 and R360A, B, C or D-R362 A, B, C or D R359-R361 is set such that the multi is reverted at the end of the last vertical equalizer pulse. (The waveform near the collector of Q365 on the diagram at the back of this manual shows capacitively-coupled pulses that pass through C361 and the base-to-collector capacitance of Q365. This is normal and does not indicate Q365 to be defective.) As Q365 collector goes negative at the end of the last equalizing pulse, C364 and R368 form a negative pulse that ramps up for a period of 50 to 55 μs, C370 couples differentiated —H pulses and adds them to the ramp at the junction of R369 and D370. If a horizontal pulse occurs during the time the ramp is running up, the output through D370 is more negative than at any other time. A two-field interlace horizontal sync pulse occurs in the middle of every other ramp.

All the other negative pulses at the junction of R369-D370 charge C371 (through R372) to an essentially stable DC voltage (R371 does not appreciably discharge C371 between pulses). As a field 2 occurs, the more negative pulse that coincides with the field 1 recognition ramp is coupled through D371 to the base of Q375, flipping the field trigger generator so that Q375 conducts.

**Field Trigger Generator.** The field trigger generator is a bistable multivibrator that changes state each time a positive pulse arrives through C347 from the vertical sync separator. The triggering pulse is coupled to the bases of Q375-Q385 through diodes D374-D384 and the RC networks of C375-C385. The positive-polarity pulse turns off the conducting transistor regardless of which is conducting. The pulses arrive at a 50- or 60-hertz output rate, depending upon LINE & FIELD RATE switch, causing the field trigger generator to have a 25- or 30-hertz output range at each collector.

If Q375 is off when the negative-going field 1 or 3 signal from the field 1 recognition circuit arrives at the base of Q375, Q375 will be turned on. A positive signal from the sync separator to each collector at the start of each field, and a negative pulse to Q375 base at each field 1 or 3 ensures that the field trigger generator output is always related to field 1 or 3 and field 2 or 4 of the composite video. The collector of Q375 always goes positive (toward ground) at the beginning of each field 1 or 3. The collector of Q385 always goes positive at the beginning of each field 2 or 4.

Field shift switching is the selection of the correct field trigger generator output pulse by a dual input single output diode switch. Positive-going trigger pulses are needed by the sweep generator, the delay generator, and the PAL frame selector. Thus to trigger on a field 1 or 3, the FIELD switch causes Q375 collector signal to be coupled on, and for a field 2 or 4, Q385 collector signal to be coupled on.

Assume a field 2 or 4 trigger is selected. The CRT display will start the sweep on a field 2 or 4 and show the field 1 or 3 at center screen. The FIELD switch (set at TWO) applies a negative bias to D377 anode, assuring that it cannot conduct the signal from Q375 collector to the following circuits. D387 will pass the positive portion of the differentiated Q385 collector signal. Differentiation of Q385 collector signal is by C384 and the parallel resistance of R388 and R411-R412. As Q385 collector rises, C384 couples the first of the full step through to D387 and the rest of the circuit. C384 soon charges, dropping the voltage at the cathode of D387 back to ground level. As Q385 collector falls, D387 disconnects the signal from the rest of the circuit and R388 recharges C384 for the next positive pulse. The contacts of K385 are described with the staircase amplifier later in this section.

**PAL Frame Trigger Generator.** The PAL frame trigger is a bistable multivibrator that changes state each time a positive pulse arrives through C1347 from the field trigger generator. The triggering pulse is coupled to the bases of Q1375-Q1385 through diodes D1374-D1384 and the RC networks of C1375-C1385. The positive-polarity pulse turns off the conducting transistor regardless of which is conducting. The pulses arrive at a 25- or 30-hertz output rate, depending upon LINE & FIELD RATE switch, causing the PAL frame trigger generator to have a 12.5- or 15-hertz output rate at each collector.

PAL frame switching is the selection of the correct PAL frame trigger generator output pulse by a dual input single output diode switch. Negative-going trigger pulses are needed by the unblanking amplifier to unblank the CRT for the two fields to be viewed. It is then allowed to blank for the two remaining fields. Thus, to view a field, the PAL FRAME SELECTOR switch causes the collector signal of either Q1375 or Q1385 to be coupled on to the unblanking amplifier. For PAL black-white and any two field per frame video signal viewing the PAL FRAME SELECTOR is set to NORM and no trigger pulses are sent on.

Assume that it is desired to look at a PAL field 2. The FIELD switch is set to ONE (EVEN) and the PAL FRAME SELECTOR switch set to one extreme. The FIELD switch provides a means of shifting fields and the PAL FRAME SELECTOR shifts frames but without positive selection of a specific frame. The CRT display will start the sweep on either field 1 or 3 and displays the next field, 2 or 4 at center screen. The next two fields after the one appearing at center screen will be blanked out to prevent confusion between the different fields. Assume that the PAL FRAME SELECTOR switch has been set in the position which connects R1389 to R1387, applying a positive bias to the anodes of D1375 and D1377, assuming that they can conduct the signal from Q1375 collector to the unblanking amplifier. When a positive pulse arrives from the field trigger generator, assume that Q1385 is turned on and Q1375 turned off. The negative pulse created by Q1375 turning off is DC coupled to the unblanking amplifier causing it to keep the CRT unblanked until a second positive trigger pulse is applied to the PAL frame Trigger Generator, at which time the CRT is blanked. The CRT will remain blanked until the next negative pulse from the PAL frame trigger generator arrives even though the sweep generator will generate a sweep for the other two fields.

## Line Selector

The line selector circuit includes the delay generator and the line pickoff circuit. The selected line-trigger pulses occur

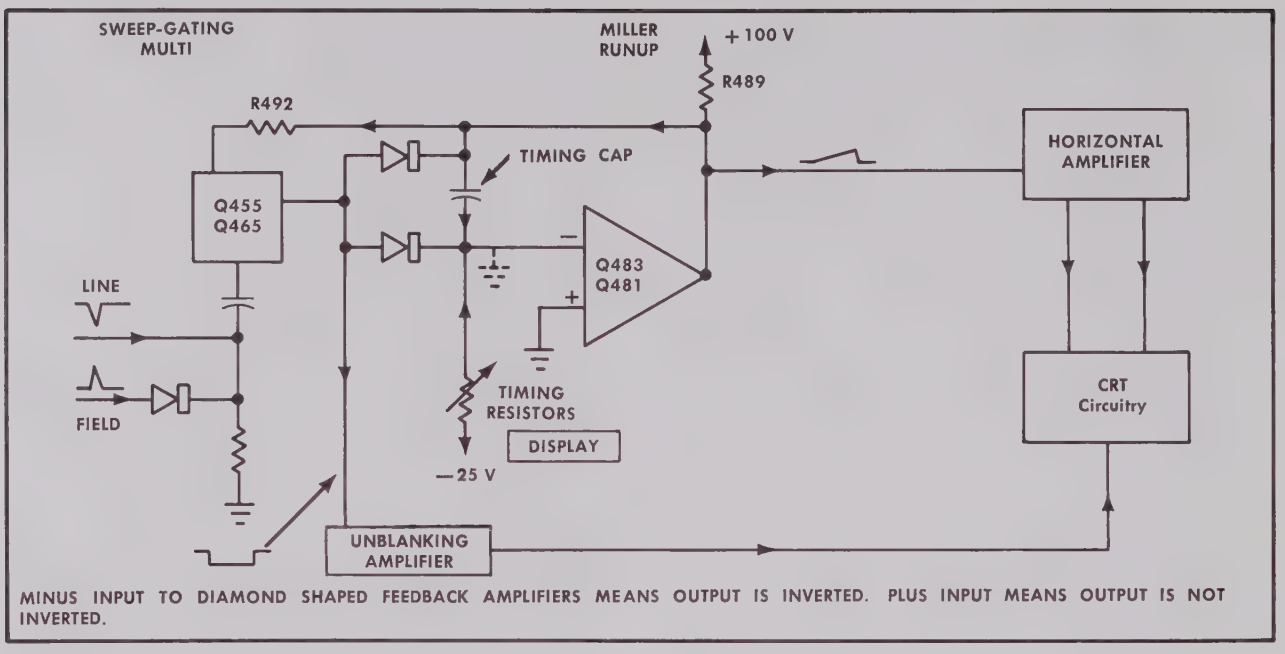



Fig. 3-10. Simplified Sweep Generator.

once each field, at an adjustable time interval after each vertical sync pulse.

**Delay Generator.** The delay generator is normally biased so Q425 is conducting and Q415 is cut off. Q415 collector rests at +24 volts because of the voltage divider R417, R418, R419 and Q434. (The LINE SELECTOR variable control current from —25 volts through R402 to the junction of R419-C428 will not take the junction significantly below ground, because a 24-volt drop exists across R418 and another of up to 25 volts across R402.) Q425 collector rests at —1 volt, holding Q415 base at about —2.6 volts by the drop across R421-R422. Q414 is saturated (collector voltage pulled down very near emitter voltage) due to base current through R417. Thus, the emitter and collector current of Q425 is set by R414 and the —24 volts at Q414 collector. The delay generator will remain in this condition until a positive trigger pulse arrives at the base of Q415.

As a positive pulse turns on Q415, the current through Q414-R414 shifts to Q415, and Q425 turns off. As Q415 collector starts negative, C415-C416 couples the voltage change into the base of Q414 in a direction to reduce its collector current. The current of Q414 is also the current of Q415, which again pulls down on C415-C416. The result of the feed-back just described is that C415-C416 is discharged in a very linear manner by current through R416. The voltage at the junction of C415-C416-R416 remains essentially constant while the collector of Q415 pulls the other side of C415-C416 negative at a rate set by the current through R416.

When the collector voltage of Q415 reaches ground level und stops going negative, current through R416 raises the base voltage of Q424 and increases its current. Increased current in Q414 pulls both Q415 and base elements negative, allowing the collector to go negative also. The common emitter-to-emitter lead of Q425-Q415 drops negative until Q425 again turns on. The collector voltage of Q425 drops and quickly turns Q415 off, letting its collector voltaage rise in the positive direction as R417 charges C417-C416 to its original state. (C418 cancels Q415 initial negative collector surge caused by shifting Q414 current from about 5 mA in Q425 to about 0.27 mA in Q415. Without C418, the collector voltage of Q415 would drop sharply negative at the time Q415 was triggered into conduction.) C415-C416 charging current is limited only by R417 since the negative end of the capacitor is tied to —25 volts through Q414 base-emitter junction.

## Sweep Generator

The sweep generator is a triggered sweep system for all positions of the DISPLAY switch except the 2 FIELD positions, at which it is a recurring synchronized sweep. Positive field-trigger pulses prevent the sweep from operating in 2 FIELD and LINE SELECTOR positions (LINE SELECTOR set to a line, lines 16 through 21). Negative line-trigger or selected line pulses start the sweep in all other modes of operation. Refer to the simplified sweep generator diagram of Fig. 3-10 and the complete diagram at the back of this manual during the following circuit description.

**Trigger Selector Matrix.** Selection of recurrent negative line trigger pulses at the beginning of each horizontal line, or of selected line pulses, is made in a diode switching network of the DISPLAY switch.

When the DISPLAY switch is at a LINE SELECTOR position and the LINE SELECTOR switch is set to a line (lines 16 through 21) position, both D441 and D444 are reverse biased so that no negative triggers get to the sweep gating

multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the sweep gating multi.

When the DISPLAY switch is at 2 FIELD, both D441 and D444 are reverse biased, so that no negative triggers get to the Sweep Gating Multi. At the same time, D452 is forward biased through R450 so positive field triggers are available to the Sweep Gating Multi.

**Sweep Gating Multi.** The sweep generator is operated in two basically different modes of operation as suggested earlier. The sweep gating multi operation is altered from a triggered system for 2 LINE, 1 LINE, 10 μS/CM, 5 μS/CM and the LINE SELECTOR positions of the DISPLAY switch with the LINE SELECTOR switch set to VARIABLE to a stopped-sweep system for both LINE SELECTOR positions of the DISPLAY switch when LINE SELECTOR switch is set to a line (lines 16 through 21), and to a free-running stopped-sweep system for 2 FIELD displays.

**2 LINE DISPLAY.** (Vertical INPUT switch at A, DISPLAY switch at 2 LINE.) The sweep generator is held in one state by the sweep gating multi until the arrival of a negative trigger pulse. Before receipt of a trigger pulse, the following conditions exist:

a. Q455 is conducting, Q465 is in a state of non-conduction.

b. Both disconnect diodes are conducting. D482 is applying positive turn-on current from R468 to the Miller runup input gate. While D481 is limiting the turn-on current, the collector of Q481 pulls down and takes some of the current flow from R468.

c. Q481 collector voltage is at about +1 volt, so that essentially no current is delivered through R520 (see horizontal amplifier diagram) to the horizontal amplifier.

d. The unblanking amplifier output is near ground, turning off the CRT beam.

e. The CRT horizontal deflection plates hold the blanked beam at the left side of the CRT (depending upon the setting of the POSITION control).

Q455 is held in conduction by current through the series resistors R464-R465 and D466, limited by R470 current into the base-emitter junction of Q474. The base turn-on current to Q455 is enough to saturate it; however, D455 bypasses some of the intended base current when the collector voltage drops slightly below D466 anode voltage. This prevents the transistor from saturating. (If Q455 were to saturate, the base-emitter junction would hold so many carriers that the transistor could not be turned off quickly.) The fact that Q455 collector voltage is near ground assures that no current reaches the base of Q465, and Q465 remains cut off.

As the negative-going line trigger pulse arrives at the base of Q455 through C452, Q455 is turned off. The voltage rise at the collector of Q455 is coupled to the base of Q465, its collector voltage drop aids in turning Q455 off and the switching action takes place very rapidly. (Consider the emitter of Q465 as grounded; the components in its emitter circuit are used in 2 FIELD and LINE SELECTOR operation when the LINE SELECTOR switch is set to a line [line 16 through 21] and are of no importantce in 2 LINE operation.) The time constant of C452 and R467 prevents Q455 from being pre-triggered by the equalizing pulses during the vertical interval time, while the sweep is running down.

**Miller Runup.** As Q465 collector voltage falls below about +1.3 volts, D464 conducts and takes the anodes of the disconnect diodes toward ground. Both D481 and D482 stop conducting. The timing resistor current that had been flowing through D482 is immediately transferred to the timing capacitor, C481A. The current that had been flowing in D481 through Q481 is cancelled by a slight drop in voltage at the base of Q481. As Q483 gate starts negative, the base of Q481 also starts negative and reduces its collector current, causing its collector voltage to start positive. The timing capacitor couples the positive voltage of Q481 collector back to Q483 gate, essentially stopping its negative travel. The result is that the timing capacitor receives a charge at a rate set by the timing resistor, creating a very linear positive-going sawtooth voltage at the collector of Q481. The Miller runup circuit can be defined as a feedback amplifier, with the feedback element a timing capacitor, and the input resistor a timing resistor; the input signal is the —25-volt supply (see Fig. 3-9 and associated text for description of a feedback amplifier). The quiescent collector voltage of Q481 is primarily determined by the bias of Q483, a FET, and zener diode D469. The voltage drop across D469 insures D482 is reverse biased during the runup time of the sweep.

The sweep voltage rises positive until R492-R494 (LINE SWEEP LENGTH) raises the base voltage of Q455 far enough to revert the sweep gating multi. As Q455 conducts, the collector voltage of Q465 raises in the positive direction. D464 stops conducting and R468 raises the gate voltage of Q483 positive through D469 and D482. This causes collector current in Q481 to increase rapidly. This collector current discharges the timing capacitor at a linear rate set by R468. As Q481 collector voltage approaches the voltage at the gate of Q483, D481 takes some of the R468 current and stops the rundown. The rate of rundown is slow enough that the sweep is triggered every other horizontal sync pulse. The sweep generator then waits for another negative line-trigger pulse to turn off Q455 and start the cycle over again.

**2 Field Display.** Operation of the sweep gating multivibrator is changed from a state where a trigger is required to start the sweep to a condition where the sweep starts automatically and is stopped by a trigger pulse. If the sweep is not running when the DISPLAY switch is set to 2 FIELD, Q465 of the sweep gating multi is not conducting. The DISPLAY switch connects R461 to the —25-volt supply and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of R461A-C463. Approximately 1 millisecond after Q465 emitter voltage starts negative, the sweep gating multi switches so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation.

The DISPLAY switch also changes the output of the trigger selector matrix, forward biasing D452 through R450 so that positive pulses will come through D452, and will turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down very rapidly (due to additional rundown current from R453 in parallel with R468), waits 1 millisecond and automatically starts again, just before the video portion of the next field.

In the event vertical input composite video stops, the sweep will continue to cycle, but instead of positive pulses stopping the sweep, Q455 is turned on by sweep voltage feedback through R491-R492-R494 in the same manner as described for 2 LINE operation. Thus, the Type RM529 MOD 188D will show a sweep without vertical information when the DISPLAY switch is set to 2 FIELD, but requires a trigger signal from the sweep to operate in all other positions of the DISPLAY switch.

With the INPUT switch set to CAL, R469 is placed in parallel with R468 so the rundown rate will be rapid enough to prepare the sweep to run again at the next calibrated signal transition. This assures a cleanly triggered calibrator display without the possible jitter caused by a longer rundown.

The runup rate of the Miller runup circuit is slowed by adding C480 across the timing capacitor used in 2 LINE operation. C480 does not affect the sweep voltage peak value, but changes only the rate at which the spot moves across the CRT. The 2 FIELD, 2 LINE and 1 LINE sweep rates are changed for the various television system field and line rates by changing the amount of capacitance in parallel with the timing capacitor.

The Miller runup circuit drives the horizontal amplifier.

**Line Selector Display.** In this mode of operation, the sweep gating multivibrator starts automatically, runs until a —H pulse latches it and causes it to switch, thus starting the sweep voltage running up. After the sweep voltage has run up, the sweep gating multivibrator is reset by a field selected frame rate trigger pulse. If the sweep is not running when the DISPLAY switch is set to the LINE SELECTOR position (LINE SELECTOR switch set to line 21), Q465 of the sweep gating multi is not conducting. The DISPLAY switch connects R461A to the —25-volt supply through R461B, R461C, R461D, R461E, R461F and R461G (if FIELD switch is set to 2) and the emitter voltage starts negative. D461 is reverse biased, and the rate of fall is set by the time constant of C463-R461A, R461B, R461C, R461D, R461E, R461F, and R461G. At a time which is determined by the setting of the LINE SELECTOR switch and the FIELD switch, after Q465 emitter voltage starts negative, it will be negative enough to be latched by one of the —H pulses applied through C462 to the emitter of Q465. The latching by the —H pulse causes the sweep gating multi to switch so that Q465 is on and Q455 off. The sweep voltage runs up as described for 2 LINE operation. After the sweep voltage has run up, the sweep gating multi is reset by a field selected frame rate trigger pulse.

Since the VIT LINE SEL RANGE control, R458, varies the base voltage of Q465 only a small amount, it is used to set the exact time that Q465 will turn on.

The DISPLAY switch also changes the output of the trigger selector matrix, forward biasing D452 through R450 so that positive pulses come through D452 and turn on Q455 to stop the sweep. The positive pulse that turns Q455 on occurs at every other vertical sync pulse. The sweep is stopped, runs down, waits for the time set by the LINE SELECTOR switch and the FIELD switch, then automatically starts again, just before the desired horizontal line.

## Unblanking Amplifier

The unblanking amplifier (Q474) responds to the sweep gating multi (Q465) collector signal except when a DC signal is being coupled to the base of Q474 from the PAL frame trigger generator. When there is no sweep, the CRT beam is pulled away from the deflection plates and phosphor screen, preventing any spot from being seen. Q474 collector is near ground at the time of no sweep, turning off the CRT beam. As the sweep gating multi switches states to start a sweep, Q474 is biased to cutoff and its collector rises to +101 volts, limited by conduction of D474 and D475.

The unblanking amplifier provides two more output signals during line selector sweep operation. One is the video output intensification discussed with the vertical amplifier description. The other increases the CRT beam current to intensify the CRT trace for the short duration of the line selector sweeps.

The collector signal of Q474 does not pull down on the trace intensification line; rather, that line is pulled down by R476 and the —5 volts of the video output amplifier circuit between sweeps when the DISPLAY switch is set to a LINE SELECTOR position. The collector voltage of Q474 is near ground most of the time in line selector mode because of the short-duration sweeps recurring at the 25- or 30-hertz rate (once every 33.3 or 40 ms). The trace intensification line (at R477-R478 junction) drops to +5 volts in about 2.6 ms as the combination of R476-R477 discharges and changes the charge on C477.

As the sweep starts, Q474 collector rises quickly, sending an integrated pulse to the CRT grid circuit. R478 permits the step to rise abruptly to +22 volts, then continue to rise at an RC rate. The rising signal to the CRT grid is required to keep the cathode current constant during the intensification period, assuring a uniform CRT intensity throughout each sweep.

R476 also conducts current into the 75 ohms of the VIDEO OUTPUT connector, adding about 0.1 volt to the video output to intensify a line of the studio monitor, identifying which line the Type RM529 MOD 188D is viewing.

## Horizontal Amplifier

The horizontal amplifier circuit includes the horizontal amplifier and the staircase amplifier. Refer to the simplified horizontal amplifier diagram of Fig. 3-11 and the complete diagram at the back of this manual during the following circuit description.

The horizontal amplifier is a combination of feedback and paraphase amplifier. The base of Q533 is the virtual ground summing input terminal to the amplifier. Voltage gain of the overall amplifier is the ratio of the MAGNIFIER resistance to the input resistance of R520. The DC level of the output (positioning) is through R525 to the base of Q533. The input to a feedback amplifier can have several input resistors and signals. The gain of each is the ratio of feedback resistor to input resistor. Feedback is from the emitter of Q554 to the base of Q553. The emitter of Q554 is also the signal source for the inverting half of the amplifier, through the VARIABLE control R555-R557 and the HORIZ GAIN control R558-R568 to the emitter of Q564. The SWP/MAG REGIS control sets the DC balance of emitter voltages of Q554/Q564 so the display center does not shift as the MAGNIFIER switch is changed.

The sweep sawtooth enters through R520. Q553 is an emitter follower and current-gain transistor, driving the inverting amplifier Q544. Q544 signal output receives current

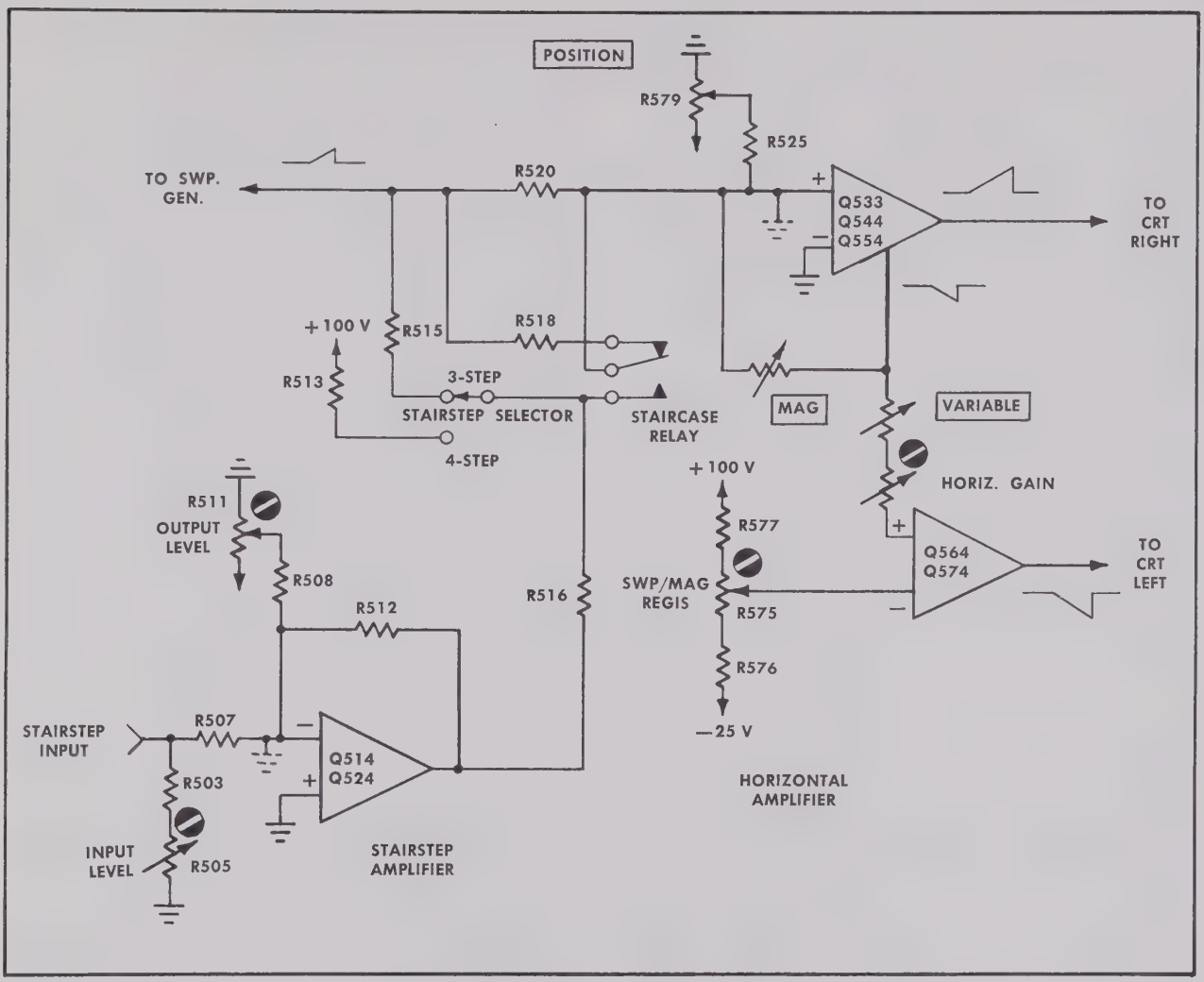



Fig. 3-11. Simplified Horizontal Amplifier.

gain in the emitter of Q554 assuring linear feedback from a low impedance. The collector of Q554 provides a +150-volt swing with the input base signal appearing inverted at the collector output.

The VARIABLE and HORIZ GAIN resistances are degenerative to Q554 and provide a signal coupling path to the emitter of Q564. The signal from the emitter of Q554 runs negative, increasing the current in the collector of Q564. Increased collector current in Q564 causes the collector to run negative and provide a voltage swing of about —150 volts.

Q514 and Q524 comprise a feedback amplifier for studio camera staircase voltages. The ratio of R507 and R512 determines the gain of the amplifier with the input staircase signal appearing amplified and inverted at the junction of R512, R514, and R516. Q514 is a field effect transistor inverting amplifier stage with its output signal driving the base of emitter follower Q524. D510 provides reverse breakdown protection for the emitter-base junction of Q524 while zener diode D519 drops the DC level of the emitter output signal to center the display on the CRT screen. R503 (Input Level) matches the amplifier input characteristics to the output characteristics of the generator providing the staircase waveform. C507 is a high-frequency compensating adjustment.

When 25 volts are applied between pins D and E of J501, K501 removes R518 from in parallel with R520. This decreases the gain of the Horizontal Amplifier by a factor of about 4 when Stairstep Selector switch SW510 is in the 4-Step position. When the Stairstep Selector switch is in the 3-Step position, R515 is switched in parallel with R520 which causes the gain of the Horizontal Amplifier to be reduced by a factor of about 3 instead of 4.

For purposes of describing circuit operation, only a 3-step staircase input will be considered. Operation for a 4-step staircase input will be the same with the exception that the sweep will be stepped one-fourth of the way across the CRT screen for each step instead of one-third.

Closing the staircase relay also changes the timing resistor so the sweep rate is twice as fast as that for 2 FIELD opera-

tion. The relay also changes the operation of the field trigger generator to put out a positive pulse at each vertical sync pulse time instead of at every other one. Thus the sweep recurs at a 60-hertz rate, taking three sweeps to get across the CRT.

With the staircase most positive, the sweep runs for the period of one field, and is reverted by a vertical sync trigger. At the time the sweep is reverted, the staircase drops negative to its second level. The sweep starts again, but begins one-third of the way across the CRT due to the staircase positioning signal. Again the sweep runs for one field, is reverted and the staircase drops to its third level. Once again the sweep starts, but two-thirds of the way across the CRT. Thus, the three color camera signals can all be viewed on one CRT display.

The staircase level shift takes about 800 $\mu$s. With the sweep gating multi operating in 2 FIELD, the sweep restarts in about 1 ms, so the change in staircase is not seen because the CRT beam is blanked off at the same time.

## Power Supplies

The low-voltage power supply provides regulated —25 volts, +100 volts, and +350 volts to the circuits of the Type RM529 MOD 188D. The —25 volt supply is the reference voltage for the +100-volt and +350-volt supplies and the calibrator circuit.

The Type RM529 MOD 188D is powered by a multiple tap primary power transformer for operation on either 115 or 230 volt 50-60 hertz line. Refer to the Operating Instructions section of this manual for converting from one supply voltage to the other.

**—25-Volt Supply.** Voltage for the —25-volt power supply comes from the fullwave rectifier system of D610-D611 and C610. Voltage across C610 is nominally 35 volts.

The —25-volt regulator consists of a comparator that compares a portion of —25 volts (divided by R624-R626 and the —25 Volts/Cal Ampl control R620) against the voltage of precision zener diode D614. D614 zener voltage is about 9.1 volts. The comparator output at Q616 collector is inverted and amplified by Q634, which drives the series transistor Q637 in a direction to compensate for changes in the output voltage.

Assume the —25-volt supply level decreases and the voltage goes slightly positive. Q626 turns on harder, reducing the current in Q616 so its collector goes positive. Q634 turns on harder and pulls Q637 base in the negative direction, causing Q637 to increase conduction and raise the output voltage back to its proper negative level. Since the collector of Q637 is grounded, the whole supply is moved by the emitter of Q637 to make the correction. R617-C617 at the base of Q634 reduces the feedback loop high-frequency gain for more stable operation with high-frequency load transients. C620 and C626 aid in reducing the high-frequency output impedance of the supply. Fuse F637 protects Q637 from accidental short circuit of the —25-volt supply bus.

The —25-volt supply is the voltage source for the heaters of V113 and V293. R621 across V293 heater compensates the heater voltage for current taken by the constant current stage of the vertical preamplifier.

The value of the —25-volt supply directly sets the peak-to-peak amplitude of the calibrator signal; therefore the control used to adjust the supply is labeled —25-Volt/Cal Ampl. See the Calibration procedure for adjustment.

D621 will prevent the —25-Volt supply output from going positive with respect to ground. This will protect the —25-Volt supply components in the event an incorrect voltage is accidentally applied to pin F of J501.

**+100-Volt Supply.** Voltage for the +100-volt supply is provided by the fullwave bridge rectifiers D640A-B-C-D and C640. The voltage across C640 is nominally 130 volts.

The +100-volt regulator compares a portion of the +100-volts (referenced to the —25-volt supply through the divider R641-R642) to ground at the emitter of Q644. Q643 is an emitter follower acting as an impedance transfer device to raise the base impedance of Q644 base and prevent loading the divider. Q644 amplifies and inverts any change at the base of Q643 and applies the change directly to the base of Q647. Q644 collector current is the total base current of Q647. Q647 emitter voltage follows the inverted correction signals, changing the level of the whole supply when needed.

Assume that the load increases, taking the +100 volts slightly negative. Q643 drives Q644 base negative, increasing its collector current. Increased Q644 collector current means increased base current in Q647, raising the emitter positive the correct amount to restore the output voltage.

Fuse F648 protects Q647 from accidental short circuit of the +100-volt supply bus.

**+350-Volt Supply.** Voltage for the +350-volt supply is provided by the fullwave bridge rectifiers D650A-B-C-D and C650. The voltage across C650 is nominally 130 volts.

The +350-volt regulator compares a portion of the +350 volts (referenced to the —25-volt supply through the divider R651-R653) to ground at the emitter of Q654. Q653 is an emitter follower acting as an impedance transfer device to raise the base impedance of Q654 base and prevent loading the divider. Q654 amplifies and inverts any change at the base of Q653 and applies the change directly to the base of Q657. Q654 collector current is the total base current of Q657. Q657 emitter voltage follows the inverted correction signals, changing the level of the whole supply when needed.

Assume that the load increases, taking the +350 volts slightly negative. Q653 drives Q654 base negative, increasing its collector current. Increased Q654 collector current means increased base current in Q657, raising the emitter positive the correct amount to restore the output voltage.

Fuse F658 protects Q657 from accidental short circuit of the +350-volt supply bus.

The +350-volt supply is used by the CRT high-voltage supply and the vertical output stage, whose current passes through the beam rotator coil. (The rectangular CRT is not easily rotated physically. Also, the earths magnetic field can cause slight changes in trace alignment with the graticule. Thus, a coil is included around the CRT proper, allowing the operator to adjust the trace alignment with the graticule.)

C649 and C644 aid in reducing the supply high-frequency impedance. R644 limits the peak current through C644 to the base of Q643 in case the supply is accidentally shorted.

R646-C646 decouple the +100-volt bus for peak current of the CRT unblanking circuit.

## CRT Circuit And Calibrator

The high voltage for the CRT elements is supplied by a high voltage oscillator circuit consisting of V800A/B, Q804, and Q874. V800A is the oscillator tube and Q874 is the feedback transistor. Q874 also develops the calibrator signal used for checking RM529 MOD 188D vertical gain. V800B and Q804 control the current through V800A thus controlling the amplitude of the oscillations. The high voltage necessary for operating the CRT is obtained from a voltage doubler circuit consisting of C822, C832, D822 and D832.

**High Voltage Oscillator.** When power is initially applied to the instrument, V800A is off because of its cold filaments, thus Q874 turns on first. As the filaments of V800 warm up, V800A starts to conduct which causes current to flow through the primary of T801. As the current through the primary of T801 increases, a voltage is induced into the secondary, with the end connected to the base of Q874 being negative. A negative going signal applied to the base of Q874 causes the transistor to decrease conduction and its collector goes in the positive direction. The positive going signal on the collector of Q874 is coupled to the grid of V800A causing the tube to increase conduction. V800A continues to increase conduction until Q874 is turned off. When Q874 is turned off the voltage at the grid of V800A is no longer changing, therefore, the current through the tube does not change. Since the current through the primary of T801 is determined by the conduction of V800A, the current through the primary is not changing and there is no voltage induced into the secondary winding. With no signal applied to the base of Q874, the transistor turns on again. As Q874 starts conducting its collector goes in the negative direction. This negative going signal is coupled to the grid of V800A causing the tube to decrease conduction. The decrease of current flow through the primary of T801 induces a positive going voltage into the secondary, which is coupled to the base of Q874 causing the transistor to increase conduction. The current through V800A continues to decrease until Q874 is driven into saturation, at which time the cycle starts over again. The signal developed on the collector of Q874 swings from approximately +0.6 V, which is set by D881, to approximately —25 V, established by the emitter voltage of Q874.

**Voltage Doubler.** As V800A is increasing conduction there is a positive going voltage induced at the junction of T801 secondary and C822. This causes D832 to be reverse biased and D822 to become forward biased, current now flows through R821, D822, and C822 to the —25 V supply. A charge is developed across C822 with the junction of T801 and C822 being positive. As V800A starts decreasing conduction, the polarity of the voltage induced into the secondary reverses, D822 is reverse biased, and D832 becomes forward biased. The charge across C822 is in series with the voltage induced into the center-tapped secondary of T801, therefore the charge developed across C832 is approximately two times the induced voltage or approximately 7 kV.

**High Voltage Regulator.** The amplitude of the signal developed in the plate circuit of V800A is controlled by V800B and Q804 which control the current through V800A. The bias on V800B is set by the adjustment of HIGH VOLTAGE adjustment, R814. This determines the current through V800B and the voltage developed in its cathode circuit. The base of Q804 is connected to the junction of R808, which limits the base current of Q804, and R809 in the cathode circuit of V800B. The conduction of V800B therefore determines the bias of Q804 which controls the current through V800A, the high voltage oscillator.

The conduction of V800B is also controlled by the voltage across R806 which is a sample of the signal amplitude developed in the plate circuit of V800A. As V800A is increasing conduction, duirng the negative half cycle of the signal developed in the plate circuit, the signal on the plate is coupled through C805, forward biasing D806 and charging C806. When V800A starts decreasing conduction and the charge on C806 becomes more negative than the signal on the plate of V800A, D806 is reverse biased. The discharge time of C806 is sufficiently long for C806 to retain most of its charge during the remainder of the cycle. The positive excursion of the signal coupled through C805 is limited to approximately +0.6 V by D805 at the cathode end of D806. C806 charges to the peak amplitude of the signal developed in the plate circuit of V800A and the voltage across R806 establishes a bias voltage on V800B. Assume the amplitude of the signal developed by the oscillator increases, this causes the charge on C806 to become more negative. The voltage at the grid of V800B becomes more negative, decreasing the current flow through the transistor and returning the amplitude of the oscillator signal to the correct amplitude.

Any current changes occuring in the CRT circuit will produce a current change through R821. The current change through R821 causes the voltage level at the grid of V800B to change and the regulator circuit reacts to compensate for this change.

The positive level at the grid of V800B is limited to +0.6 V by D810. R818/C818 is a frequency compensating network and C819 is a filter for 120 cycle ripple. The screen grid of V800A is clamped at +100 V by D803. If the oscillator tube tries to draw excessive current the voltage drop across R803 will increase, reducing the screen voltage and limiting the current.

## CRT Circuit

The high voltage developed by the voltage doubler is applied to a divider which provides the correct operating potential for the cathode, control grid, and focusing anode of the CRT. The voltage drop across R846, R847, and R848 is maintained at a fixed value by zener diode D847. This insures the supply voltage to the CRT cathode will remain at a constant level regardless of any current changes through the divider. C850 filters out any voltages ripple between the CRT grid and cathode which would intensity modulate the CRT trace. The CRT cathode current can be checked by measuring the voltage across R850. The voltage should typically be 0.15 volts which would indicate the current to be 150 $\mu$A (plus meter current). The voltage across R850 is set by the adjustment of Beam Current R848.

In the LINE SELECTOR modes of the DISPLAY switch, there is a trace intensification pulse coupled to the CRT grid. To prevent any de-focusing that might occur, R833 is added to the divider which increases the negative voltage at the focusing anode to maintain the same voltage relationship between the control grid and focusing anode thereby keeping the trace in focus. R833 is shorted out in the other modes of the DISPLAY switch.

## CRT Control Circuits

The INTENSITY control adjusts the DC potential of the control grid, thus controlling the quantity of electrons in the electron beam.

Focus of the CRT display is controlled by FOCUS control R844. The voltage applied to the focus grid is more positive (less negative) than the voltage on either the control grid or the CRT cathode. ASTIG adjustment R864, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid.

The Unblanking Bias adjustment, R863, changes the difference of potential between the unblanking plates and is adjusted for uniform intensity on the CRT.

The TRACE ROTATION adjustment controls the current through L655, which rotates the beam in order to align the trace with the graticule.

## Calibrator

The square wave that is developed in the collector circuit of Q874 swings between approximately +0.6 V (set by D881) and —25 V (set by the emitter voltage of Q874) and is used as the calibrator signal. When the VOLTS FULL SCALE switch is in the 1.0 position the 25 V signal is divided down by R881, R885, R886, and R887 for use in the vertical amplifier. When the VOLTS FULL SCALE switch is in either the 0.5 or 0.2 position, the gain of the vertical amplifier is increased and R883 (or R883 and R882) is added to the divider to induce the amplitude of the Cal Signal to maintain the display on screen. The .714 F.S. and 0.7 F.S. positions of the CALIBRATOR switch changes the point in the divider at which the output is taken off, thereby changing the amplitude of the Cal Signal out.

With the CALIBRATOR switch in the EXT position, the external calibrator input impedance is 1 megohm.

# SECTION 4
# MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

## Introduction

This section of the manual contains information for use in preventive maintenance, troubleshooting and corrective maintenance of the Type RM529 MOD 188D.

## PREVENTIVE MAINTENANCE

### General

Preventive maintenance consists of cleaning, visual inspection and lubrication. Preventive maintenance performed on a regular basis may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the Type RM529 MOD 188D is subjected determines the frequency of maintenance.

### Cleaning

**General.** The Type RM529 MOD 188D should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

CAUTION

**Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone, or similar solvents.**

**Exterior.** Loose dust accumulated on the outside of the Type RM529 MOD 188D can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

**Interior.** Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or circuit boards.

**CRT.** Clean the graticule and the CRT face with a soft, lint-free cloth dampened with denatured alcohol.

### Lubrication

**General.** The reliability of potentiometers, rotary switches and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant (e.g., Tektronix Part No. 006-0229-00). Potentiometers which are not permantly sealed should be lubricated with a lubricant which does not affect electrical characteristics (e.g., Tektronix Part No. 006-0220-00). The pot lubricant can also be used on shaft bushings. Do not over-lubricate. A lubrication kit containing the necessary lubricants and instructions is available from Tektronix, Inc. Order Tektronix Part No. 003-0342-00.

### Visual Inspection

The Type RM529 MOD 188D should be inspected occasionally for such defects as broken connections, loose or disconnected square pin connectors, improperly seated transistors, damaged circuit boards and heat-damaged components.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

### Transistor Checks

Periodic checks of the transistors in the Type RM529 MOD 188D are not recommended. The best check of transistor performance is its actual operation in the instrument. More details on checking transistor operation are given under trouble-shooting.

### Recalibration

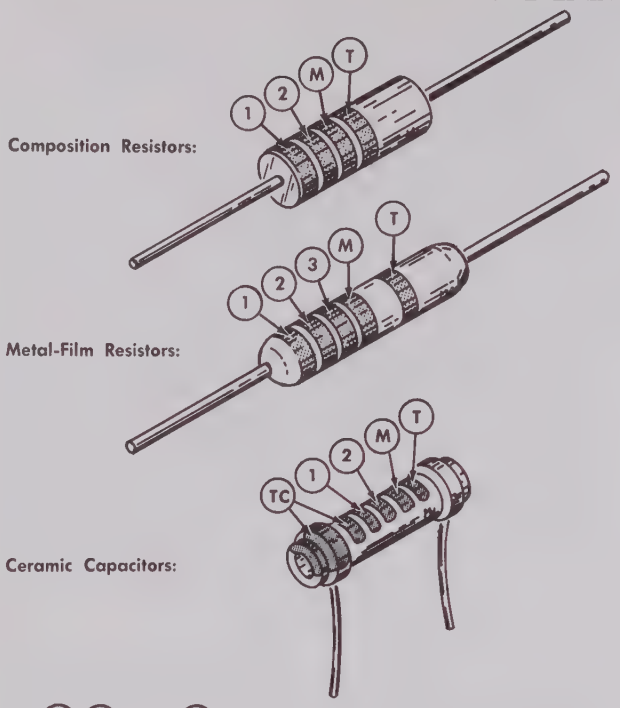
To assure accurate measurements, check the calibration of this instrument after each 500 hours of operation or every 6 months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuit. Complete calibration instructions are given in the Calibration section.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by recalibration.

## TROUBLESHOOTING

### Introduction

The following information is provided to facilitate trouble-shooting of the Type RM529 MOD 188D. Information con-




**Resistor and Capacitor Color Code**

| Color | Significant Figures | Multiplier: Resistors | Multiplier: Capacitors | Tolerance: Resistors | Tolerance: Capacitors |
|---|---|---|---|---|---|
| Silver | --- | $10^{-2}$ | --- | ±10% | --- |
| Gold | --- | $10^{-1}$ | --- | ±5% | --- |
| Black | 0 | 1 | 1 | --- | ±20% or 2 pF* |
| Brown | 1 | 10 | 10 | ±1% | ±1% or 0.1 pF* |
| Red | 2 | $10^{2}$ | $10^{2}$ | ±2% | ±2% |
| Orange | 3 | $10^{3}$ | $10^{3}$ | ±3% | ±3% |
| Yellow | 4 | $10^{4}$ | $10^{4}$ | ±4% | +100% −0% |
| Green | 5 | $10^{5}$ | $10^{5}$ | ±0.5% | ±5% or 0.5 pF* |
| Blue | 6 | $10^{6}$ | $10^{6}$ | --- | --- |
| Violet | 7 | --- | --- | --- | --- |
| Gray | 8 | --- | $10^{-2}$ | --- | +80% −20% or 0.25 pF* |
| White | 9 | --- | $10^{-1}$ | --- | ±10% or 1 pF* |
| (none) | --- | --- | --- | ±20% | ±10% or 1 pF* |

*For capacitance of 10 pF or less.

(1) (2) and (3) —1st, 2nd and 3rd significant figures;
(M) —multiplier; (T) —tolerance;
(TC) —temperature coefficient.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-1. Color code for resistors and ceramic capacitors.

tained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

## Troubleshooting Aids

**Diagrams.** Circuit diagrams are given on foldout pages in Section 8. The component number and electrical value of each component in this instrument are shown on the diagrams. Each main circuit is assigned a diagram number. Table 4-1 lists the main circuits in the Type RM529 MOD 188D and their assigned diagram numbers. Important voltage and waveforms are also shown on the diagrams. The portions of the circuit mounted on circuit boards are enclosed with a blue line.

**Circuit Boards Photographs.** Fig. 4-5 shows the location of each circuit board within the instrument. Figs. 4-6 through 4-10 show partial and/or full views of each circuit board. Each electrical component on the boards is identified by its circuit number, and all wire color codes are shown. These pictures, used along with the diagrams, aid in locating the components located on the circuit boards.

**Wiring Color Code.** All insulated wire and cable used in the Type RM529 MOD 188D is color-coded to faciliate circuit tracing. Signal carrying leads are identified with one or two colored stripes. Regulated voltage supply leads are identified with three stripes to indicate the approximate voltage, using the EIA resistor color code. A white background color indicates a positive voltage and a tan background indicates a negative voltage. The widest color stripe identifies the first color of the code. Table 4-2 gives the wiring color-code for the power supply voltages used in the Type RM529 MOD 188D.

**TABLE 4-1**

| Diagram Number | Circuit |
|---|---|
| 1 | Vertical Ampliier |
| 2 | Response Switch |
| 3 | DC Restorer |
| 4 | Sync Separator |
| 5 | Field and Frame Selector |
| 6 | Line Selector |
| 7 | Sweep Generator |
| 8 | Horizontal Amplifier |
| 9 | Power Supply |
| 10 | CRT Circuit and Calibrator |

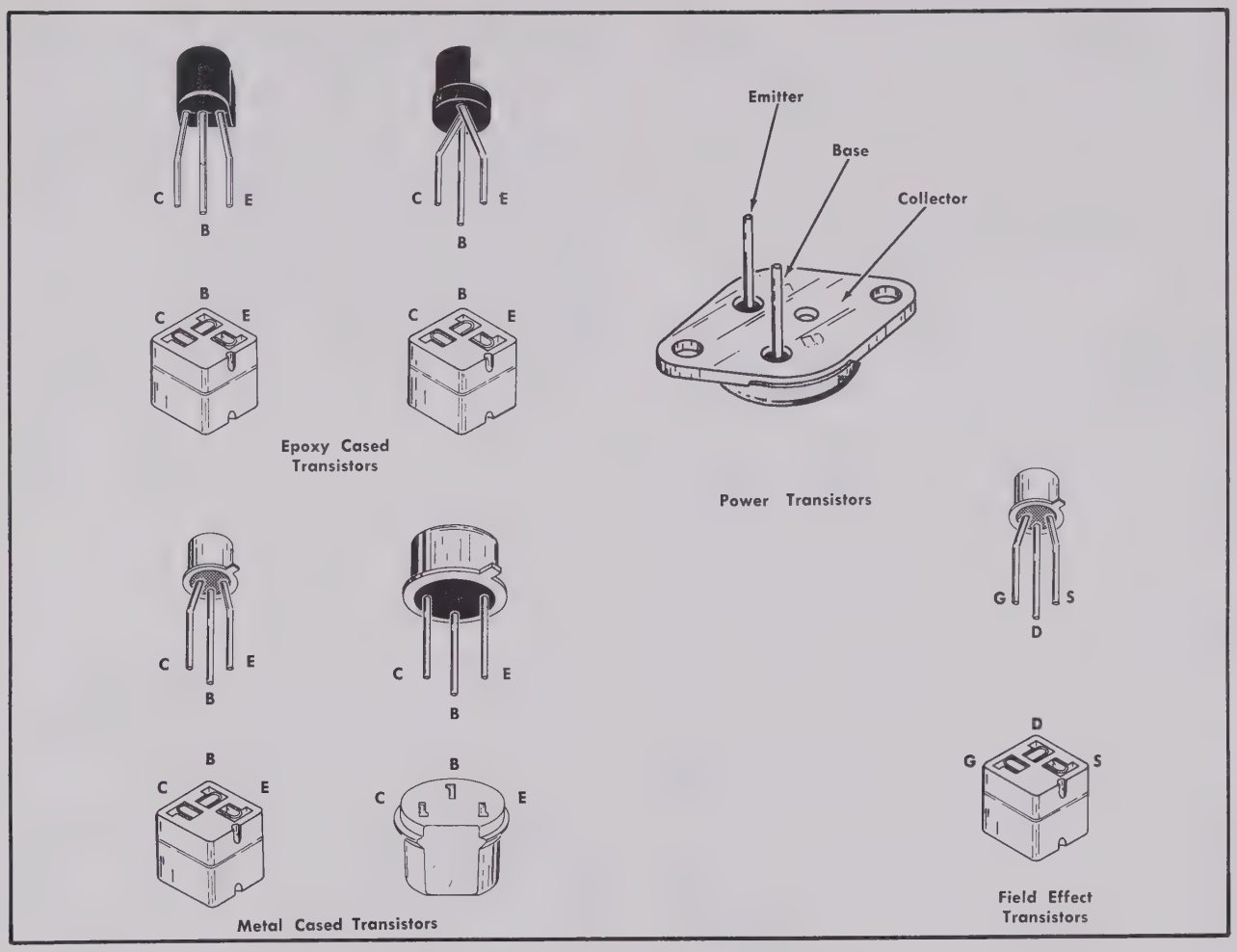



Fig. 4-2. Transistors and sockets used in this instrument.

TABLE 4-2

Power Supply Wiring Color Code

| Supply | Background Color | First Stripe | Second Stripe | Third Stripe |
|---|---|---|---|---|
| +350 | White | Orange | Green | Brown |
| +100 | White | Brown | Black | Brown |
| −25 | Tan | Red | Brown | Black |

**Resistor Color Code.** In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the Type RM529 MOD 188D. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components (some metal-film resistors may have the value printed on the body) with the EIA color code. The color code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 4-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

**Capacitor Marking.** The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The tubular ceramic capacitors used in the Type RM529 MOD 188D are color coded in picofarads using a modified EIA color code (see Fig. 4-1).

**Diode Color Code.** The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the color-code identifies the three significant digits of the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded pink or blue-brown-gray-green indicates Tektronix Part Number 152-0185-00). The cathode and anode ends of a metal-encased diode can be identified by the diode symbol marked on the body.

**Transistor Lead Configuration.** Fig. 4-2 shows transistor types and sockets used in the Type RM529 MOD 188D.

## Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type RM529 MOD 188D:

1. Transistor Tester

Description: Tektronix Type 576 Transistor-curve Tracer or equivalent.

Purpose: To test the semiconductors used in this insrument.

2. Multimeter

Description: VOM, 20,000 ohms/volt DC. 0 to 6000 volts range; ohmmeter, 0 to 100 megohms; accuracy, within 3%. Test prods must be insulated to prevent accidental shorts.

NOTE

**This instrument may be checked with a VTVM, 10 megohm input impedance and 0 to 500 volts range ;ohmmeter, 0 to 50 megohms; accuracy within 3%.**

Purpose: To check voltages and for general troubleshooting in this instrument.

3. Test Oscilloscope

Description: DC to 30 MHz frequency response (signal tracing). 20 millivolts to 200 volts/division deflection factor using a 10× probe.

Purpose: To check waveforms in this instrument.

## Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Check Control Setting. Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of this manual.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type RM529 MOD 188D check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

3. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment and may be corrected by calibration. Complete calibration instructions are given in the Performance Check/Calibration section of this manual.

5. Isolate Trouble to a Circuit. To isolate trouble to a circuit, note the trouble symptoms. The symptoms often identify the circuit in which the trouble is located. For example, poor focus indicates that the CRT (includes high voltage) circuit is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Table 4-3 lists the tolerances of the power supplies in this instrument. If a power-supply voltage is within the listed tolerance, the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the Calibration section to adjust the power supplies.

**TABLE 4-3**

Power Supply Tolerance

| Power Supply | Tolerance |
|---|---|
| +350 | 5% |
| +100 | 5% |
| −25 | 3% |

After the defective circuit has been located, proceed with step 6 through 8 to locate the defective component(s).

6. Check Circuit Board Interconnections. After the trouble has been isolated to a particular circuit, check the pin connectors on the circuit board for correct connection.

7. Check Voltage and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

**Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the inside portion of the Vertical Amplifier diagram pull-out page.**

WARNING

**Shield braids are not always at ground potential. Check the schematic before using such connections as a ground for the voltmeter test prod or oscilloscope probe. Some transistor cases may be above ground potential.**

8. Check Individual Components. The following procedures describe methods of checking individual components in the Type RM529 MOD 188D. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a new transistor or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be dam-

aged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 576). Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

B. TUBES. Tester checks on tubes used in the Type RM529 MOD 188D are not recommended. Tube testers sometimes indicate a tube to be defective when that tube is operating satisfactorily in a circuit, or they may fail to indicate tube defects which affect the performance of the circuits. The standard of usability of a tube is whether or not it works properly in the circuit. If it does not, it should be replaced. Unnecessary replacement is not only expensive, but may also cause needless recalibration of the instrument.

C. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high on one direction and very low when the leads are reversed.

CAUTION

**Do not use an ohmmeter scale that has a high internal current. High current may damage the diode.**

D. RESISTORS. Check the resistors with an ohmmeter. Check the Electrical Parts List for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

E. INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll-off).

CAUTION

**L101 and L201, feed-through coils, should not be moved, expanded or compressed. Refer to Section 5, step 43, for any adjustment.**

F. CAPACITORS. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open coupling capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes AC signals.

9. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedure given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

# CORRECTIVE MAINTENANCE

## General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

**Standard Parts.** All electrical and mechanical part replacement for the Type RM529 MOD 188D can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE

**When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it it known that a different component will not adversely affect instrument performance.**

**Special Parts.** In addition to the standard electronic components, some special components are used in the Type RM529 MOD 188D. These components are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

**Ordering Parts.** When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.

2. Instrument serial number.

3. A description of the part (if electrical, include circuit number).

4. Tektronix Part Number.

## Soldering Techniques

WARNING

**Disconnect the instrument from the power source before soldering.**

**Ceramic Terminal Strips.** Solder used on the ceramic terminal strips should contain about 3% silver. Use a 40- to 75-watt soldering iron with a $\frac{1}{8}$ inch wide chisel-shaped tip. Ordinary 60/40 solder can be used occasionally without damage to the ceramic terminal strips. If ordinary solder is used repeatedly, or if excessive heat is applied, the solder-to-ceramic bond can be broken.

A small supply of solder containing about 3% silver is included on a spool mounted inside this instrument on the rear panel. Additional solder should be available locally, or it can be purchased from Tektronix in one-pound rolls; order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering ceramic terminal strips:

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

**Circuit Boards.** Use ordinary 60/40 solder and a 15 to 20 watt pencil type soldering iron on the circuit boards. A higher wattage soldering iron may separate the etched wiring from the base material.

The tip should be made of copper and have a chisel or beveled shape, with a $\frac{1}{8}$ inch width. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint.

The following technique should be used to replace a component on a circuit board. Most components can be replaced without removing the boards from the instrument.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out. A vacuum-type desoldering tool can also be used for this purpose. If the removal is not accomplished in the first few seconds of heat application, go to another connection or wait a few minutes before reheating the connection. This is to avoid transferring too much heat to the substrate.

3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

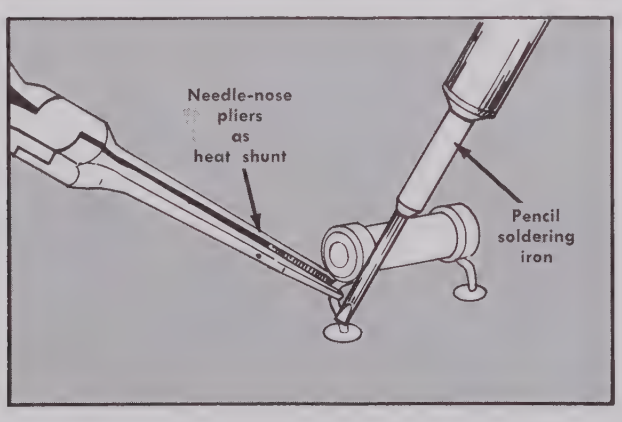



**Fig. 4-3. Use of a heat sink to protect components during soldering.**

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint; do not apply too much solder. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers (see Fig. 4-3) or other heat sink.

5. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

**Metal Terminals.** When soldering to metal terminals (e.g., switch terminals, potentiometers, etc), ordinary 60/40 solder can be used. Use a soldering iron with a 40- to 75-watt rating and a $\frac{3}{16}$ inch wide wedge-shaped tip.

Observe the following precautions when soldering to metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

3. If a wire extends beyond the solder joint, clip off the excess.

4. Clean the flux from the solder joint with a flux-remover solvent.

## Component Replacement

WARNING

**Disconnect the instrument from the power source before replacing components.**

**Ceramic Terminal Strips.** A complete ceramic terminal strip assembly is shown in Fig. 4-4. Replacement strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be re-used unless they are damaged.

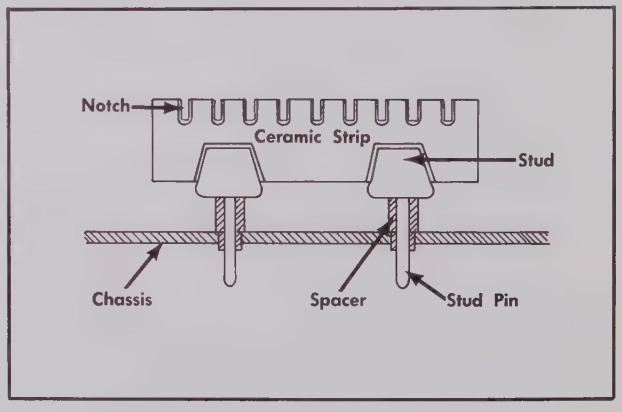



**Fig. 4-4. Ceramic terminal strip assembly.**

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until they are completly seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

**Circuit Boards.** If the circuit board is damaged beyond repair, replacement can be made of the entire assembly including all soldered-on components, or of the board alone. Part numbers are given in the Mechanical Parts List for either the completely wired or the unwired board. Most of the components mounted on the circuit boards can be replaced with-

out removing the boards from the instrument. However, if the bottom side of a board must be reached, the following procedure outlines the removal and replacement of the boards.

Removal:

1. Disconnect all square pin connectors from the board.

2. Remove all the mounting screws or nuts.

3. Release the board from the plastic clips, if used, and remove from instrument by pulling straight out.

Circuit Board Replacement:

1. Position the circuit board over the mounting holes, pins or bolts and push straight down until board is firmly held by plastic clips, if used.

2. Install all mounting screws or nuts and tighten equally. Each screw or nut must be installed to insure a good electrical connection between the board and chassis.

3. Connect all pin connectors, if any.

**Cathode-Ray Tubes.** Use care when handling a CRT. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a CRT, place it face down on a smooth surface with a protective cover or soft mat under the faceplate to protect it from scratches.

The following procedure outlines the removal and replacement of the cathode-ray tube.

WARNING

**High vacuum cathode ray tubes are dangerous to handle. To prevent personal injury from flying glass in case of tube breakage, wear a face mask (or safety goggles) and gloves. Handle the CRT with extreme care. Do not strike or scratch it. Never subject it to more than moderate force or pressure when removing or installing. Always store spare CRT's in original protective cartons. Save cartons to dispose of used CRT's.**

Removal:

1. Remove the bezel nuts, bezel and graticule.

2. Carefully remove the five neck leads. Use long-nose pliers and slowly pull each clip off its neck pin.

3. Loosen the 6-32 bolt in the white plastic CRT rear neck clamp.

4. Place one hand over the CRT face. With the other hand push gently on the CRT socket until the tube moves slightly forward. Remove the socket and push on the center of the CRT base. Carefully guide the tube out the front, without touching the magnetic shield with the neck pins.

CAUTION

**Handle with care. Due to the high vacuum that exists inside the CRT, scratching any of the external surfaces or rough handling increases the implosion hazard.**

Replacement:

1. Position the tube with the single neck pin at the top, two neckpins at both the side and bottom.

2. Carefully insert the tube into the magnetic shield, being careful not to touch the shield with the neck pins.

3. Extend the finger of one hand into the rear end of the shield to help guide the base into place. Push the CRT the last 1/4 inch with the plastic graticule so the front of the tube is flush with the front panel.

4. Tighten the 6-32 bolt in the plastic clamp until the CRT neck is held firmly. DO NOT OVERTIGHTEN.

5. Use long-nose pliers and carefully install the neck clips to the neck pins; observe the color code as marked on the shield near each opening.

6. If the CRT face is not parallel with the front panel, use a 7/64-inch hexagonal wrench to loosen the two hexagonal headed bolts at the mounting clamp. Raise, lower, or otherwise position the CRT socket so the face is correctly positioned. Tighten the hexagonal headed bolts and check that the neck pins are not grounded.

7. Re-install the graticule, bezel and bezel nuts. Recalibrate the instrument in accordance with the Calibration procedure.

**Transistor and Tube Replacement.** Transistors and tubes should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement may affect the calibration of this instrument. When transistors or tubes are replaced, check the operation of that part of the instrument which may be affected.

CAUTION

**The Power switch must be turned off before removing or replacing transistors.**

Replacement transistors or tubes should be of the original type or a direct replacement. Re-mount the transistors in the same manner as the original. Transistors which have heat radiators use silicone grease to increase heat transfer. Replace the silicon grease when replacing these transistors.

WARNING

**Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.**

Fig. 4-2 shows the lead configurations of the transistors used in this instrument. This view is as seen from the bottom of the transistor.

**Fuse Replacement.** Table 4-4 gives the rating and function of the fuses used in this instrument.

**TABLE 4-4**

| Fuse | Value | Function |
|---|---|---|
| F601 | 1A slow | Line fuse (220V) |
| F637 | 0.8A slow | —25 volt power supply protection |
| F648 | 0.3A fast | +100 volt power supply protection |
| F658 | 0.3A fast | +350 volt power supply protection |

**Switches.** If a switch is defective, replace the entire assembly. Replacement switches can be ordered by referring to the Parts List for the applicable part numbers.

When replacing a switch, tag the leads and switch terminals with corresponding identification tags as the leads are disconnected. Then, use the old switch as a guide for installing the new one. An alternative method is to draw a sketch of the switch layout and record the wire color at each terminal. When soldering to the new switch be careful that the solder does not flow beyond the rivets on the switch terminals. Spring tension of the switch contact can be destroyed by excessive solder.

**Power Transformer Replacement.** Be sure to replace only with a direct replacement Tektronix transformer.

When removing the transformer, tag the leads with the corresponding terminal numbers to aid in connecting the new transformer. After the transformer is replaced, check the performance of the complete instrument using the Performance Check procedure.

**High Voltage Components.** The components are located on the High Voltage board. To remove or repair this section, refer to circuit board removal and replacement procedure provided in this section.

NOTE

**All solder joints in the high voltage section should have smooth surfaces. Any protrusions may cause high-voltage arcing at high altitudes.**

## Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. Since the low voltage power supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the low voltage supply or if the power transformer has been replaced. The Performance Check procedure in Section 5 provides a quick and convenient means of checking instrument operation.

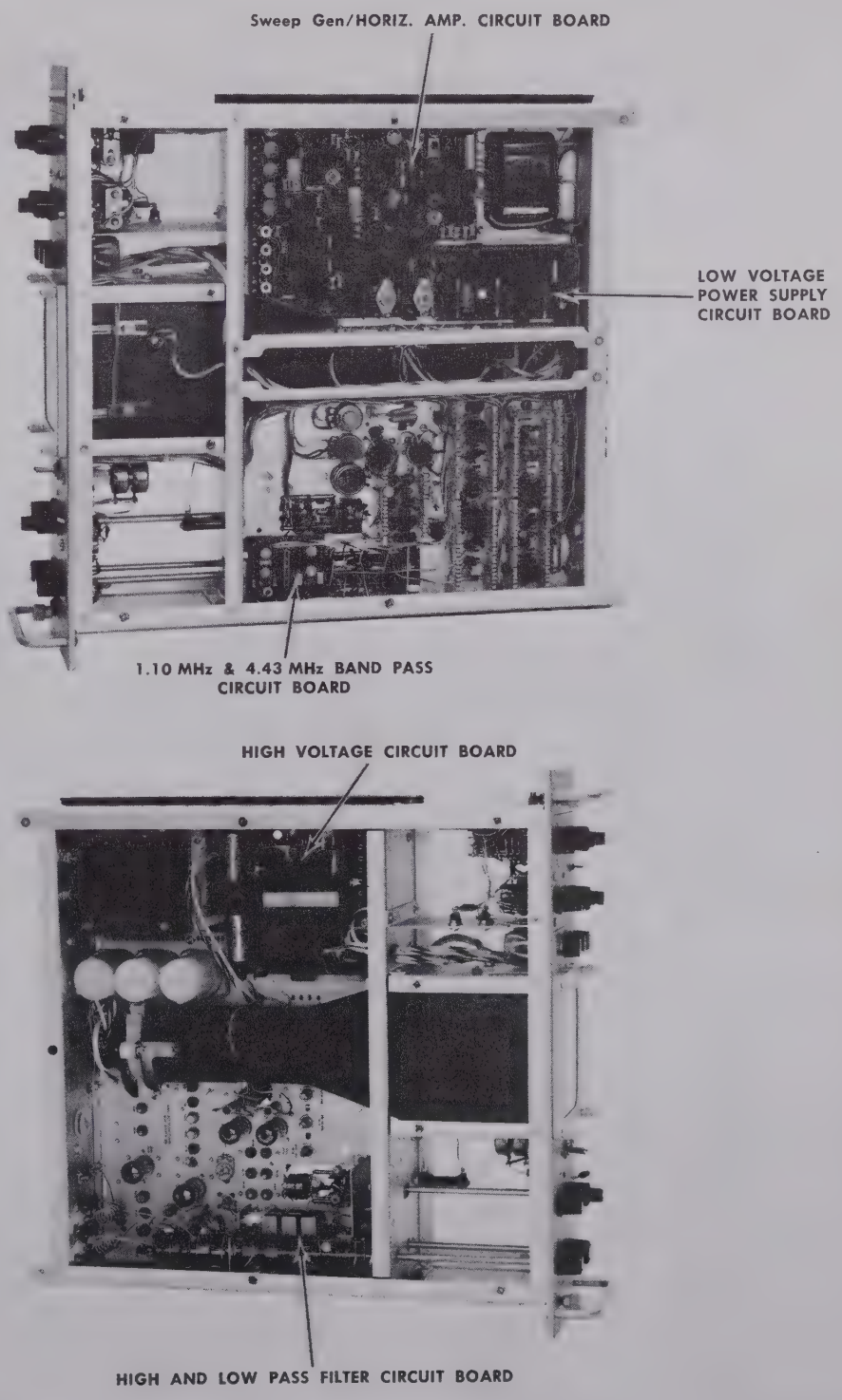



Fig. 4-5. Location of circuit boards in the Type 529 MOD 188D.

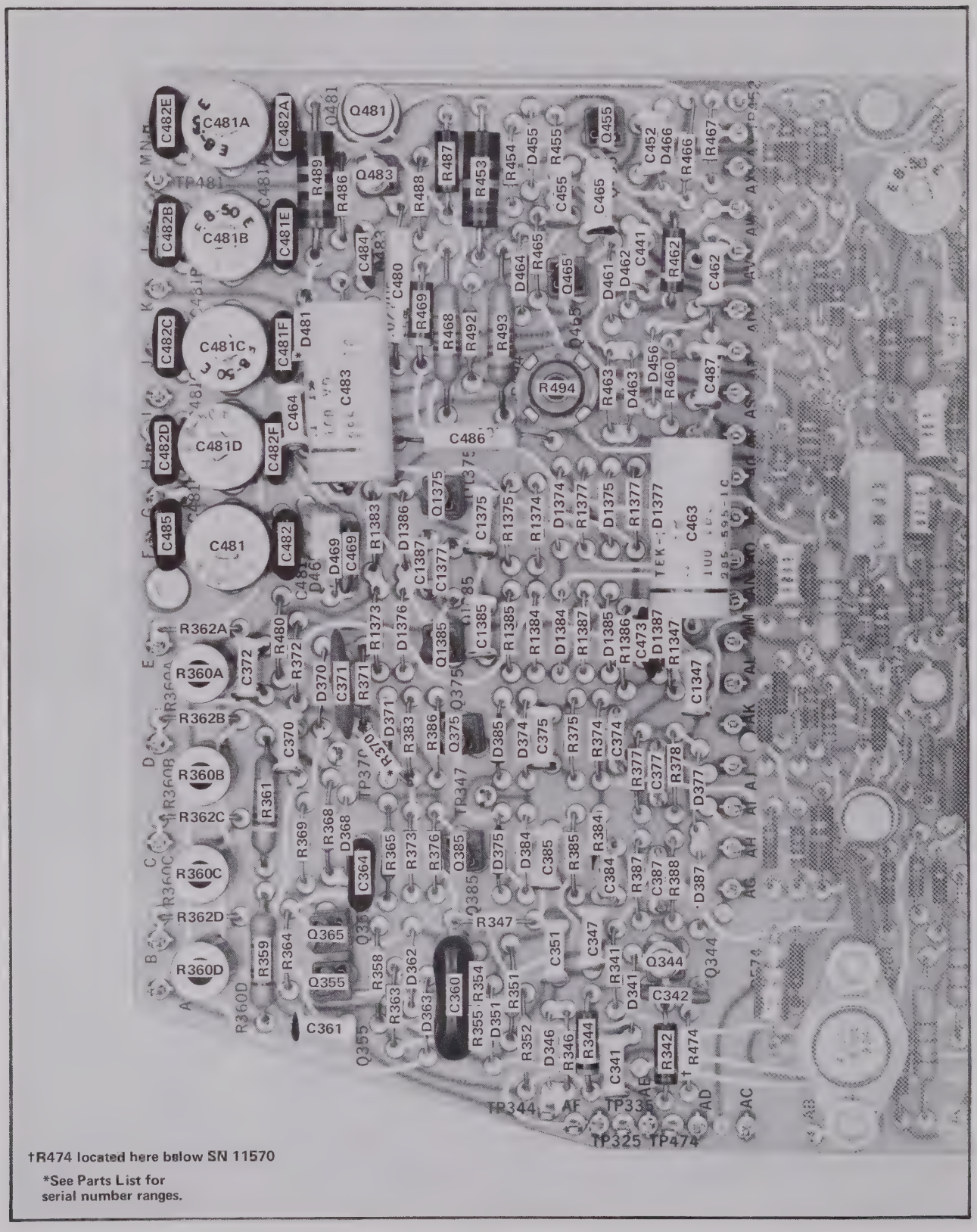



Fig. 4-6. Partial top view of Sweep Generator and Horizontal Amplifier board showing components locations.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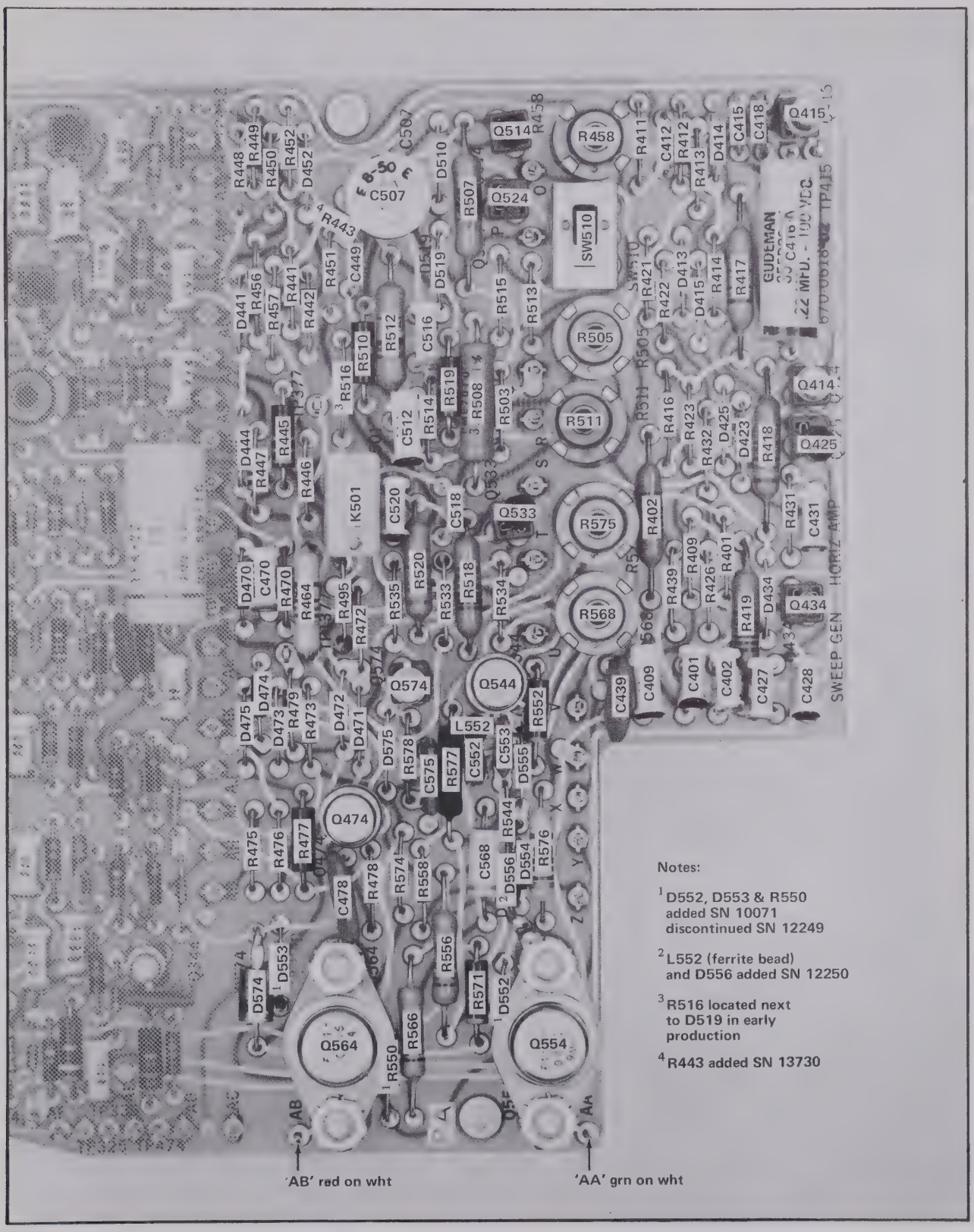



Fig. 4-7. Partial top view of Sweep Generator and Horizontal Amplifier board showing components location and wire color codes.

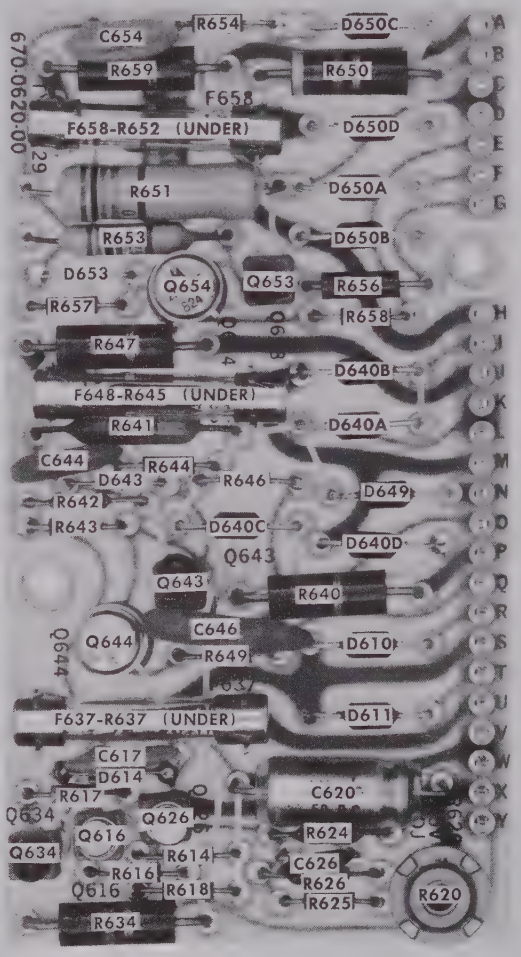



Fig. 4-8. Top view of Low-Voltage Power Supply board showing component locations.

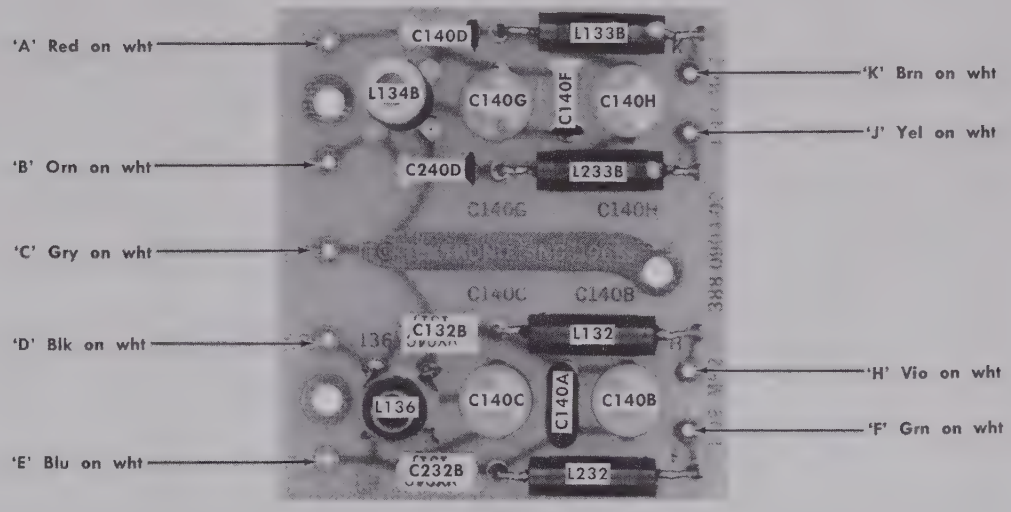



Fig. 4-9. Top view of 1.09 MHz and 4.43 MHz Response Filter board showing component location and wire color codes.

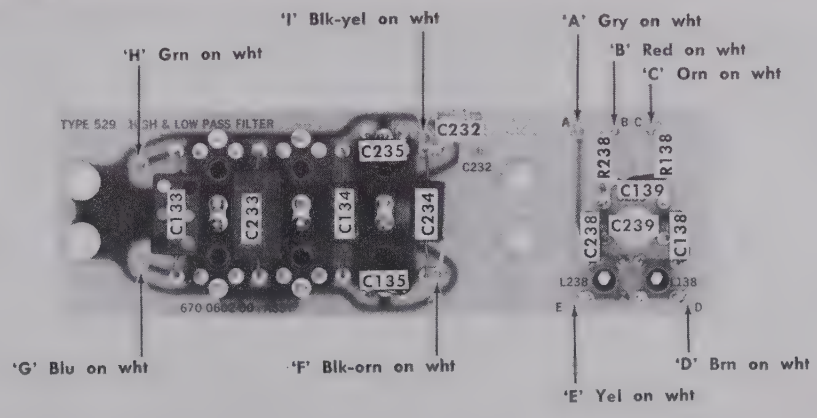


Fig. 4-10. Top and bottom view of High and Low Pass Filter board showing component locations and wire color code.

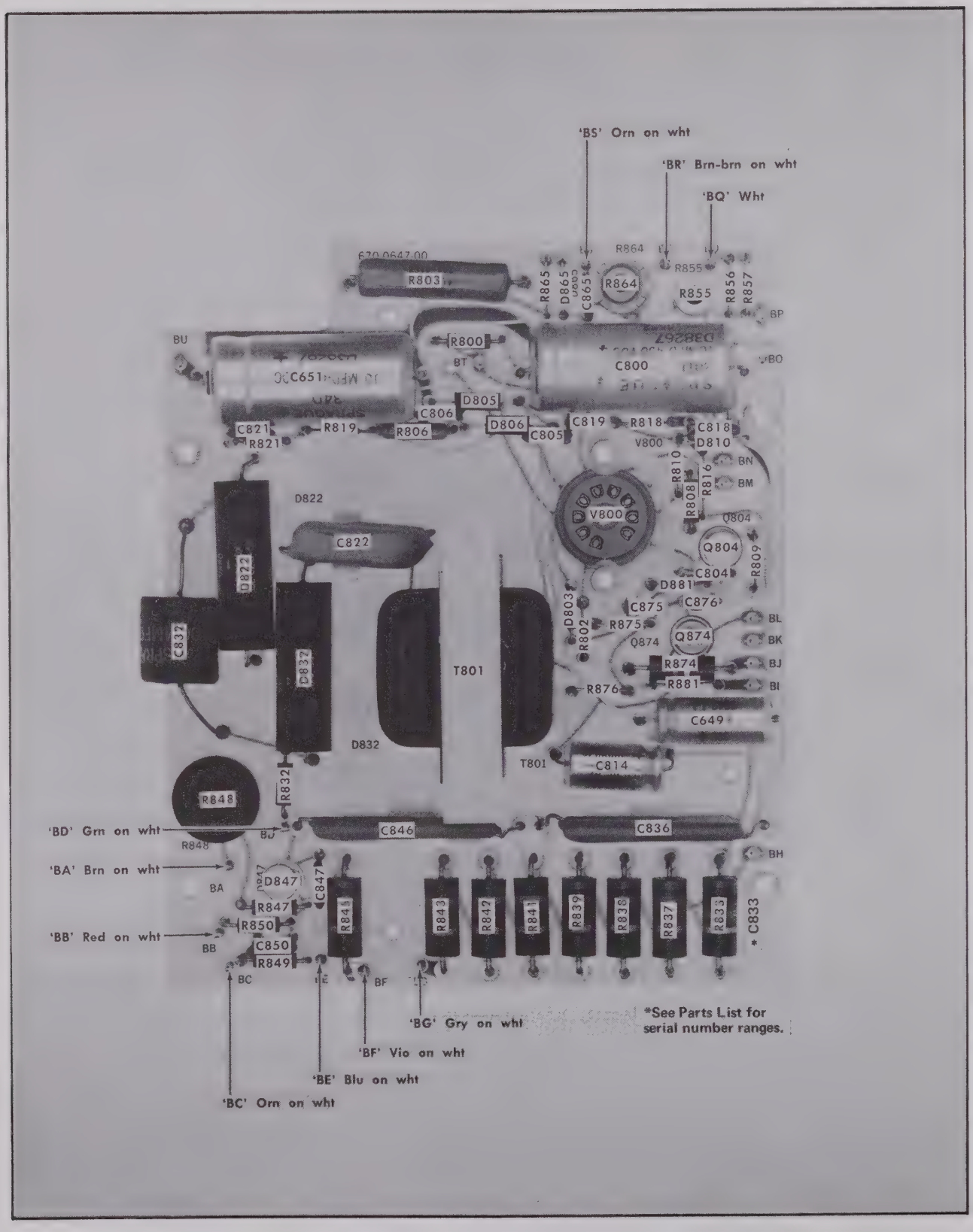



Fig. 4-11. Top view of High Voltage power supply board showing component locations and wire color codes.

# SECTION 5
# PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

## Introduction

This procedure checks and/or calibrates the instrument to the performance requirements listed in the Specification section.

**Performance Check.** This part of the procedure checks the operation of the instrument without removing the covers or making internal adjustments. However, screwdriver adjustments located on the front panel are adjusted in this part of the procedure.

If the instrument does not meet the performance requirements given in the Performance Check, internal checks and/or adjustments are required.

**Calibration Procedure.** This part of the procedure can return the Type RM529 MOD 188D to its original performance standards by completion of every step. Limits, tolerances, and waveforms in this section are given as calibration guides and are not instrument specifications. To merely touch up the calibration, perform only steps entitled "Adjust . . .". A short-form calibration procedure is also provided in this section for the convenience of the experienced calibrator.

The Type RM529 MOD 188D should be checked, and recalibrated if necessary, after each 500 hours of operation, or every six months if used infrequently, to assure correct operation and accuracy.

## TEST EQUIPMENT REQUIRED

### General

All of the following test equipment, or its equivalent, is required for complete calibration of the Type RM529 MOD 188D. Some, but not all, of the following test equipment will be required for the performance chock. Test equipment used in this procedure is illustrated in the setup pictures relating to the steps in which the particular items of test equipment are used.

Specifications given are the minimum necessary for accurate calibration. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For ease and accuracy in calibration, special calibration fixtures are used where necessary. All calibration fixtures listed are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within -% at 25 and 100 volts, and checked to within 3% at 6400 volts. For example, Triplett Model 630 NA with high voltage probe.

2. Constant amplitude sine-wave generator. Frequency 50 kHz and 350 kHz to above 10 MHz; output amplitude, 200 mV to 1 volt adjustable; amplitude accuracy within ±3%. Tektronix Type 191 or equivalent.

3. Test oscilloscope. Bandwidth, DC to 1 MHz; minimum deflection factor, 0.005 volts/division. Tektronix Type 545B Oscilloscope with Type 1A5 Plug-In Unit, and Tektronix P6006 and P6028 Probes, or equivalent.

4. Precision DC voltmeter. Accuracy, within ±0.25%; meter resolution, 50 μV; range, 0.02 to 30 volts. For example, Fluke Model 825A meter.

5. Time-Mark generator. Marker outputs of 1 μs, 5 μs, 10 μs, 0.1 ms and 0.1 μs; accuracy, within 0.001%. Tektronix Type 184 or equivalent.

6. Variable autotransformer[1]. Must be capable of supplying at least 80 watts to the Type RM529 MOD 188D over a voltage range of 96 to 137 volts (192 to 274 volts for 230-volt normal line). For example, General Radio W10MT3W Metered Variac Autotransformer. If autotransformer used does not have an AC voltmeter to indicate output voltage, monitor output with an AC voltmeter (RMS) with range of at least 137 (or 274) volts.

7. Return Loss Bridge. Tektronix calibration fixture 067-0576-00 recommended.

8. Composite video signal source. Calibrated signal amplitude of 1 volt, variable from 200 mV to 1 volt. For example, Tektronix Type 067-0601-00 television test signal generator.

9. Square-wave generator. Frequency of 120 hertz; output amplitude variable from 4 to 12 volts. Tektronix Type 106 or equivalent.

10. Three terminations (SN 10100-up). Impedance 75 ohms; accuracy, within ±3%; BNC connector; Tektronix Part No. 011-0102-00.

10A. Three terminations (SN 9500 thru 10099). Impedance 75 ohms; accuracy within ±3%; UHF connector; Tektronix Part No. 011-0023-00.

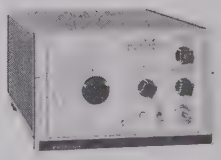
11. Two cables. Impedance 75 ohms; Type RG11/U; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0074-00.

12. Adapter (SN 10100-up). Connectors, BNC female to female. Tektronix Part No. 103-0028-00.

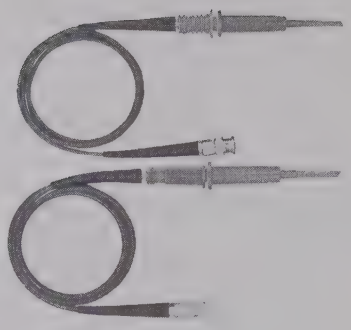
12A. Adapter (SN 9500-10099). Connectors, BNC jack to UHF plug. Tektronix Part No. 103-0015-00.

[1]**Used only to check power-supply ripple in step 2. May be deleted if this check is not made. Not required for performance check procedure.**

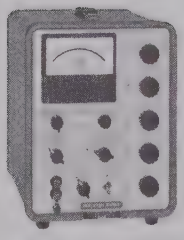
(1)



(2)

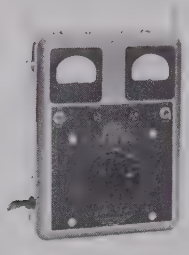


(3)



(4)

(5)



(6)

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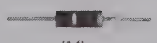
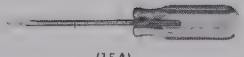
(11)

(12)

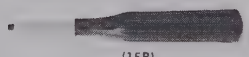
(13)



(14)



(15A)



(15B)

(15C)

Fig. 5-1. Recommended Calibration equipment.

13. Adapter. Connectors, BNC T with two female and one male. Tektronix Part No. 103-0030-00.

14. One resistor, 27 kΩ ±5%, 1/4 watt. Tektronix Part No. 315-0273-00.

15. Adjustment tools (see Fig. 5-1).
a. Screwdriver, shank about 3 inches long by 3/32-inch wide tip. Tektronix Part No. 003-0192-00.

b. Insulated low-capacitance screwdriver, Jaco No. 125, 1 1/2-inch long shank by 1/8-inch metal tip. Tektronix Part No. 003-0000-00.

c. Hexagonal wrench 5 inches long, for 0.100-inch inside diameter powdered-iron hex slug. Tektronix Part No. 003-0301-00.

## CALIBRATION RECORD AND INDEX

This short-form procedure is provided to aid in checking the calibration of the Type RM529 MOD 188D. It may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers and titles correspond to those in the complete procedure, this procedure also serves as an index to the complete Calibration Procedure. Each step is labeled to indicate whether it is a calibration step, a performance check, or both. If it applies to both procedures, there is no special labeling. Performance requirements correspond to those given in the Specification section.

Type RM529 MOD 188D, Serial No., _____

Calibration Date _____

Calibration Technician _____

☐ 1. Adjust —25 VOLTS/CAL AMPL (Page 5-6)
Calibration. Adjust —25 Volts control, R620.

☐ 2. Check Low-Voltage Power Supply Regulation (Page 5-7)
Performance Check

☐ 3. Adjust GAIN (High Voltage) (Page 5-8)
Calibration. Adjust GAIN control, R814.

☐ 4. Adjust CRT Beam Current (Page 5-9)
Calibration. Adjust CRT Beam Current control, R848.

☐ 5. Adjust Astigmatism (Page 5-9)
Calibration. Adjust Astigmatism control, R864.

☐ 6. Adjust TRACE ROTATION (Page 5-9)
Calibration. Adjust TRACE ROTATION control, R655.

☐ 7. Adjust Unblanking Plate Bias (Page 5-10)
Calibration. Adjust Unblanking Plate Bias control, R855.

☐ 8. Adjust DC Bal (Page 5-10)
Calibration. Adjust DC Bal control, R115.

☐ 9. Adjust Var. DC Bal (Page 5-10)
Calibration. Adjust Var. DC Bal control, R130.

☐ 10. Adjust Vert. Gain (Page 5-12)
Calibration. Adjust Vert. Gain Control, R169.

☐ 11. Adjust Vertical 0.2 Volts Full Scale Gain. (Page 5-12)
Calibration. Adjust 0.2 Volts Gain control, R119.

☐ 12. Check Vertical Volts Scale Gain Accuracy. (Page 5-12)

☐ 13. Adjust Trig Multi Bias (Page 5-13)
Calibration. Adjust Trig. Multi Bias control, R325.

☐ 14. Check External Sync Operation. (Page 5-14)

☐ 15. Check DC RESTORER switches. (Page 5-14)

☐ 16. Adjust Horiz Gain and Line Sweep Length (Page 5-15)
Calibration. Adjust Horiz Gain Control, R568, and the Line Sweep Length control, R494.

☐ 17. Adjust Sweep/Mag Regis (Page 5-16)
Calibration. Adjust Swp/Mag Regis control, R575.

☐ 18. Adjust Miller Timing Capacitors C481A, C481B, C481C, and C481D. (Page 5-16)

☐ 19. Check ×1 Sweep Timing (Page 5-18)

☐ 20. Adjust 5 μs/Cm Sweep Timing (Page 5-20)
Calibration. Adjust C481.

☐ 21. Check ×5 and ×10 Magnified Sweep Timing. (Page 5-21)

☐ 22. Adjust ×20 Magnified Sweep Timing (Page 5-21)
Calibration. Adjust ×20 MAGNIFIER controls, C527 and R528.

☐ 23. Adjust ×25 Magnified Sweep Timing (Page 5-21)
Calibration. Adjust ×25 MAGNIFIER controls, C523 and R524.

☐ 24. Check MAGNIFIER VARIABLE control. (Page 5-21)

☐ 25. Adjust Field 1 Sync (Page 5-23)
Calibration. Adjust Field/Sync controls, R360A, R360B, R360C, and R360D.

☐ 26. Check FIELD switch. (Page 5-25)

☐ 27. Check Line Selector Brightening Pulse Amplitude. (Page 5-26)

☐ 28. Adjust VIT Line Sel Range (Page 5-21)
Calibration. Adjust VIT Line Sel Range controls R458 and R461H.

☐ 29. Check LINE SELECTOR Operation (Page 5-28)

☐ 30. Check PAL FRAME SELECTOR switch. (Page 5-28)

☐ 31. Check A-DC COUPLED Position of Vertical INPUT switch. (Page 5-28)

☐ 32. Check Vertical Amplifier Frequency Response (Page 5-29)

☐ 33. Adjust Vertical Amplifier 1.0 FLAT Frequency Response (Page 5-30)
Calibration. Adjust C269, L162, and L262.

☐ 34. Adjust Vertical Amplifier 0.5 FLAT Frequency Response (Page 5-31)
Calibration. Adjust C118B.

☐ 35. Adjust Vertical Amplifier 0.2 FLAT Frequency Response (Page 5-31)
Calibration. Adjust C118C.

☐ 36. Adjust Common Mode Rejection (Page 5-31)
Calibration. Adjust C119.

☐ 37. Adjust Vertical Amplifier 1.10 MHz Frequency Response (Page 5-32)
Calibration. Adjust L136, C140B.

☐ 38. Adjust Vertical Amplifier 3.58 MHz Frequency Response (Page 5-32)
Calibration. Adjust C239, L138, and L238.

☐ 39. Adjust Vertical Amplifier 4.43 MHz Frequency Response (Page 5-33)
Calibration. Adjust C140G and C140H.

☐ 40. Adjust Vertical Amplifier LOW PASS Frequency Response (Page 5-33)
Calibration. Adjust L135, L235, L134, L234, L133, L233, and L232.

☐ 41. Adjust Staircase Amplifier Compensations (Page 5-35)
Calibration. Adjust C507, R505, and R511.

☐ 42. Adjust $Sin^2$ Pulse and Bar Response (Page 5-36)
Calibration. Adjust C167.

☐ 43. Adjust Instrument Return Loss (Page 5-37)
Calibration. Adjust L101 and L201.

## PERFORMANCE CHECK/CALIBRATION PROCEDURE

### General

The following procedure is arranged in a sequence designed for checking or calibrating with minimum interaction of adjustments and reconnection of equipment. However, some adjustments affect the calibration of other circuits within the instrument and it may be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked are noted.

**Performance Check Procedure.** Each performance requirement will be found at the start of the related step in the Perfor nance Check procedure.

**Calibration Procedure.** Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section.

The steps titled "Adjust . . ." in the following procedure provide a check of instrument performance, whenever possible, before the "CALIBRATION ADJUST— . . ." step is performed. The symbol ◐ is used to identify the steps in which an adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met. However, when performing a complete calibration, best overall performance will be provided if each adjustment is made to the exact setting, even if the "CALIBRATION CHECK— . . ." step is within the allowable tolerance.

**Equipment Setup Illustrations.** In the following procedure, a test equipment setup picture is shown for each major group of adjustments and checks. Following each setup picture is a complete list of front-panel control settings for the Type RM529 MOD 188D. To aid in locating individual controls which have been changed during the complete performance check and/or calibration, these control names are printed in bold type. If only a partial performance check and/or calibration is performed, start with the preceding setup. Type RM529 MOD 188D control titles are capitalized (e.g., RESPONSE).

The following procedure uses the equipment listed under Equipment Required. If equipment is substituted, control settings or test equipment setups may need to be altered to meet the requirements of the equipmnt used.

NOTE

**All waveforms shown in this procedure are actual waveform photographs taken with a Tektronix Oscilloscope Camera System.**

### Preliminary Procedure

1. (Calibration procedure only.) Remove the Type RM529 MOD 188D from any enclosure and remove the top and bottom covers for access to all internal adjustments and test points, including rear panel connectors.

2. Check that a Type RM529 MOD 188D composite video graticule marked off in 140 IRE units is installed.

3. Connect the autotransformer to a suitable power source, and the Type RM529 MOD 188D to the autotransformer output.

4. Set the autotransformer output voltage to the center of the voltage range for which the Type RM529 MOD 188D transformer has been wired.

5. Set the front panel controls of the Type RM529 MOD 188D as described below.

6. Set the Type RM529 MOD 188D POWER switch to on. Allow at least 5 minutes warmup at 25°C, ±5°C before checking the instrument to the given accuracy.

## NOTES

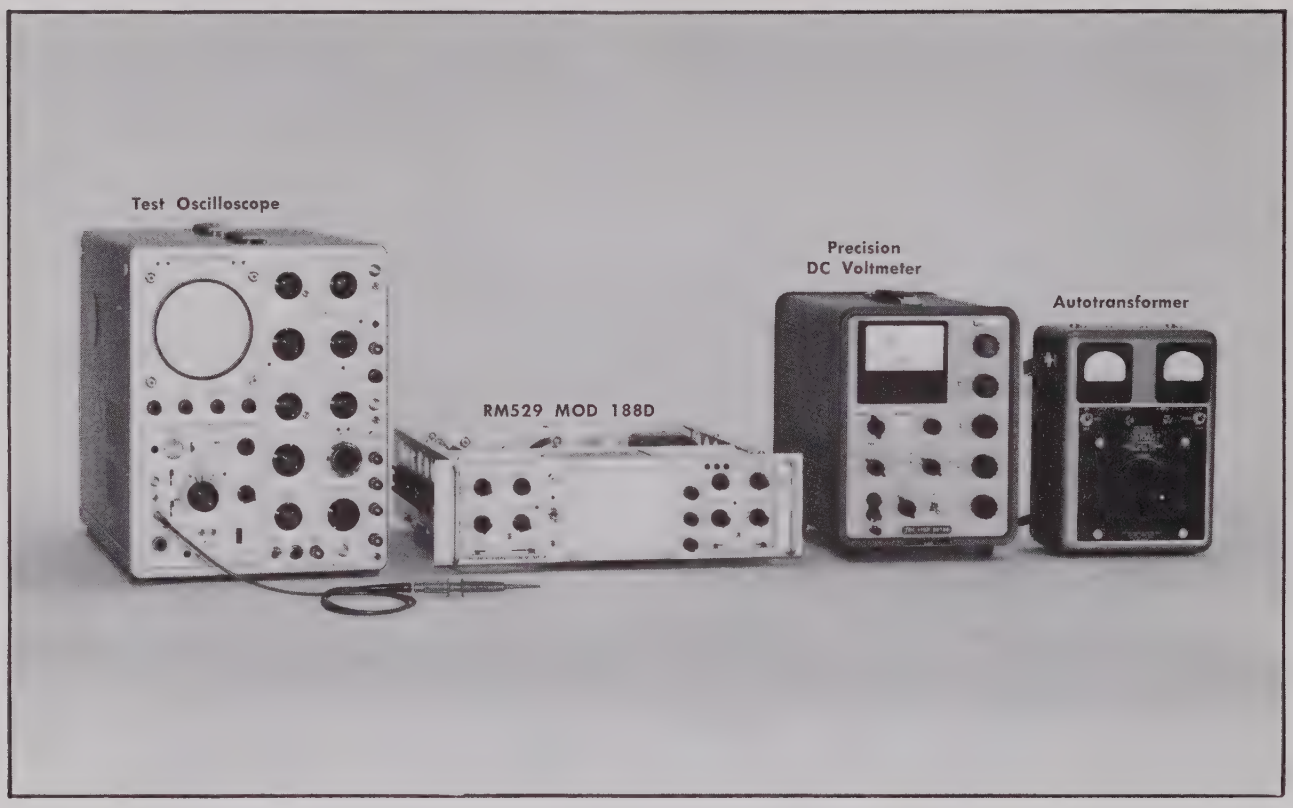



Fig. 5-2. Test equipment setup for steps 1 and 2.

Set Type RM529 controls as follows:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Fully counterclockwise |
| GAIN | Midrange |

VERTICAL Controls

| | |
|---|---|
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | CAL |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | FULL SCALE |
| POSITION | Midrange |

HORIZONTAL Controls

| | |
|---|---|
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

## Checks And Adjustments

### 1. Adjust —25 VOLTS/CAL AMPL (R620)

If this procedure is being used as a performance check, omit this step and proceed to step 2.

NOTE

**Do not reset the —25 VOLTS/CAL AMPL (R620) unless the power-supply voltages are actually out of tolerance or you are planning to perform a complete calibration of the instrument.**

a. Test equipment setup is shown in Fig. 5-2.

b. Turn off the Type RM529 power.

c. Remove Q804 and Q874.

d. Turn on the Type RM529 power.

e. Connect the precision DC voltmeter between the junction of R885-R881 and ground. See Fig. 5-3B.

f. Note the exact meter reading.

g. Turn off the Type RM529 power.

h. Reinstall Q874 and connect a ¼ watt, 27 kΩ resistor between the base of Q874 and ground.

i. Turn the Type RM529 power on.

j. Note the exact meter reading; it should be approximately —0.976 volts.

k. Calibration Check—Check that 1.0 volt minus the meter reading noted in part f of this step equals the meter reading noted in part j of this step.

l. Calibration Adjust—Adjust the —25 VOLTS/CAL AMPL control (R620; see Fig. 5-3A) until the meter reading equals 1.0 volt minus the meter reading noted in part f of this step.

NOTE

**Without the use of a high input impedance precision DC voltmeter such as item number four in the Equipment Required list, adjustment accuracy within 1% cannot be obtained.**

m. Turn off the Type RM529 power.

n. Remove the 27 kΩ resistor from Q874 and re-install Q804.

o. Disconnect the voltmeter.

p. Turn the Type RM529 power on.

q. Interaction—may affect operation of all circuits.

## 2. Performance Check-Check Low-Voltage Power-Supply Regulation and Ripple

WARNING

**Steps 2 and 3 of this procedure requires the measurement of dangerous voltages.**

a. Test equipment setup is shown in Fig. 5-2.

b. Set the CAL switch to .714 F.S. to display 100 IRE units of vertical deflection.

c. Vary the autotransformer so the line voltage is set 10% above design center (for 115 V, +10% is 126.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple according to the information given in Table 5-1.

d. Vary the autotransformer so the line voltage is set 10% below design center (for 115 V, —10% is 103.5 V) and hold for 1 minute at this voltage extreme. Check voltage regulation and ripple as given in Table 5-1.

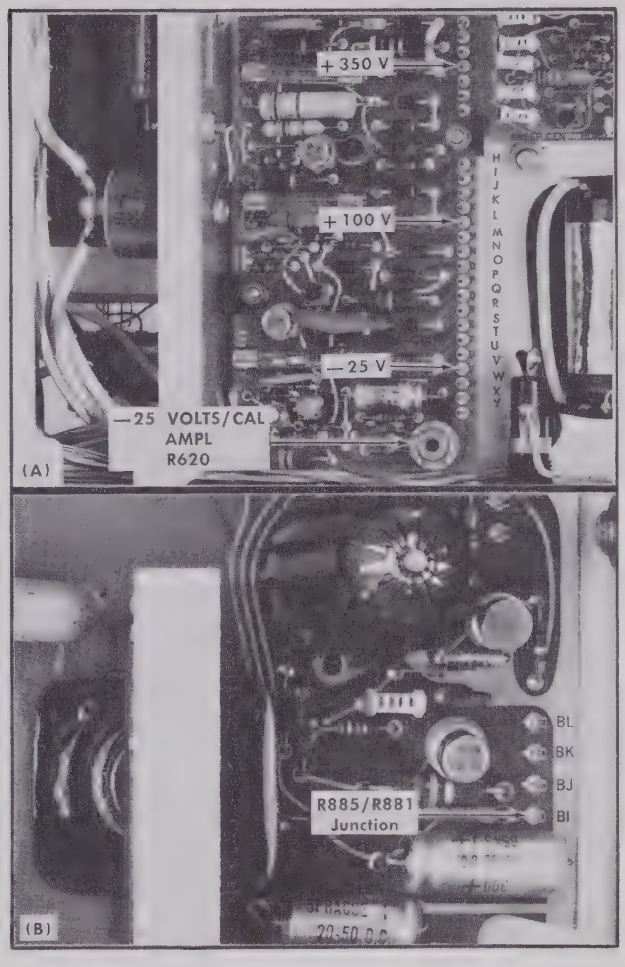



**Fig. 5-3. (A) Location of —25 VOLTS/CAL AMPL adjustment, (B) Location of low-voltage power supply test points.**

TABLE 5-1

Typical Ripple Amplitudes

| Supply | Voltage Deviation[1] | Ripple Amplitude |
|---|---|---|
| —25 V | ±1% or 0.25 V | ≤ 10 mV |
| +100 V | ±5% or 5 V | ≤ 100 mV |
| +350 V | ±5% or 17.5 V | ≤ 200 mV |

**[1]Deviation from the voltage reading obtained at design center; for example, if —2 V supply indicates a reading of —25.7 V on the DC voltmeter at design center, deviation should be within the range from —25.45 to —25.95 V.**

e. Set the autotransformer for design center line voltage.

f. Disconnect the DC voltmeter and 1× probe.

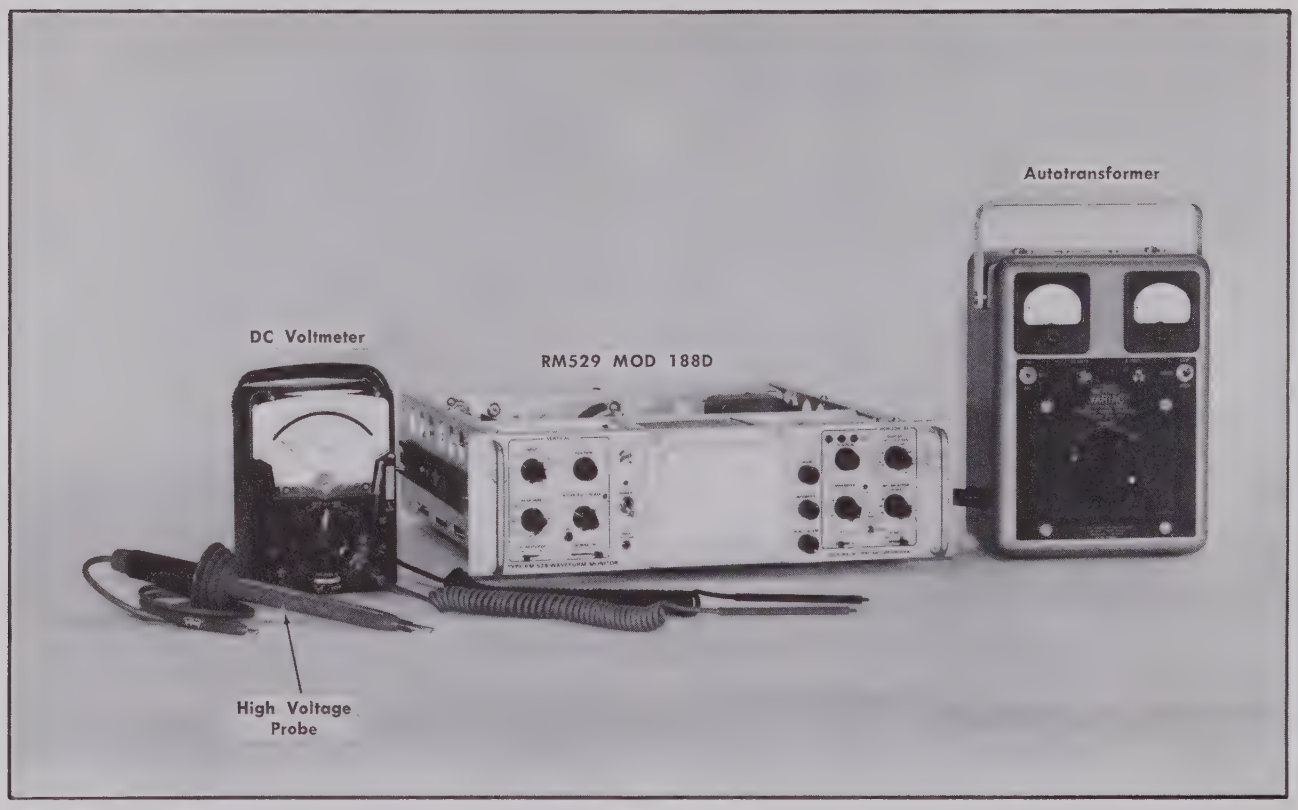



**Fig. 5-4. Test equipment required setup for steps 3 through 9.**

Set Type RM529 controls as follows:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| **INTENSITY** | **Adjust for normal display brightness** |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | CAL |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| **CAL** | **.714 F. S.** |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

### 3. Adjust GAIN (high voltage) R814

a. Test equipment required is shown in Fig. 5-4.

b. Set the DC voltmeter to measure approximately negative 6400 volts (use the instruction manual for the voltmeter as a guide); connect the voltmeter between the junction of R845/R850 (see Fig. 5-5A) and ground.

c. Calibration Check—Check for a meter reading of —6400 volts.

d. Calibration Adjust—Adjust GAIN control R814 (screw driver adjustment located on the front panel) for a meter reading of —6400 volts.

e. Interaction—May affect operation of all circuits.

f. Performance Check—Check High Voltage regulation.

g. Performance Check—Vary the autotransformer so the line voltage is set 10% above design center and hold for 1 minute at this exereme. Check that the high voltage remains essentially constant (within ±3% or 192 volts of the —6400 volt reading).

h. Performance Check—Vary the autotransformer so the line voltage is set 10% below design center and hold for 1 minute at this extreme. Check that the high voltage remains essentially constant (within ±3% or 192 volts of the —6400 volt reading).

i. Set the autotransformer for design center line voltage, and disconnect the voltmeter.

### 4. Adjust CRT Beam Current (R848).

WARNING

While performing the following parts of this step, each meter lead will be elevated approximately 6400 volts with respect to ground.

a. Test equipment required is shown in Fig. 5-4.

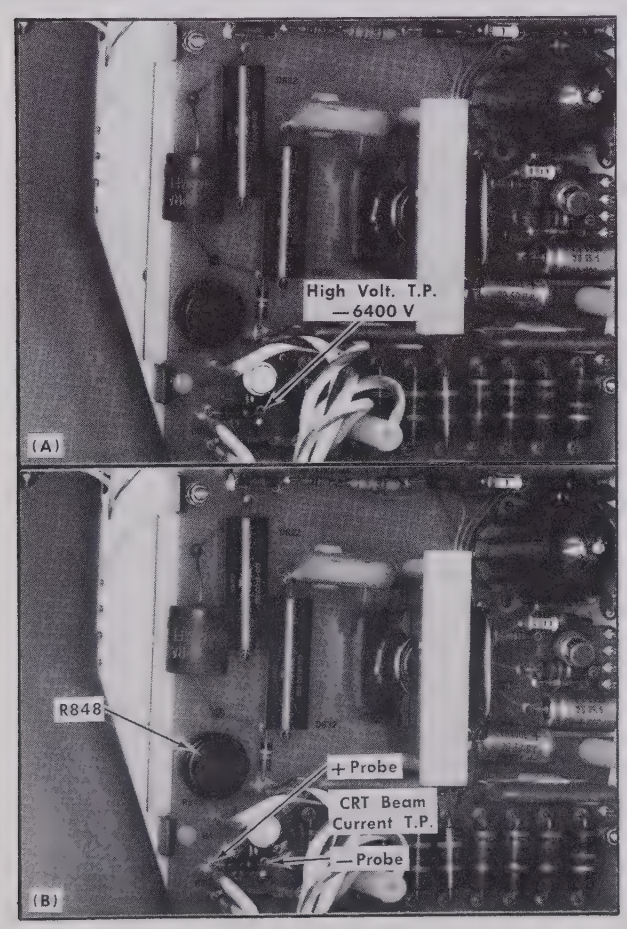



**Fig. 5-5. (A) Location of high-voltage test point. (B) Test points for adjusting CRT Beam Current & Location of CRT Beam Current adjustment (R848).**

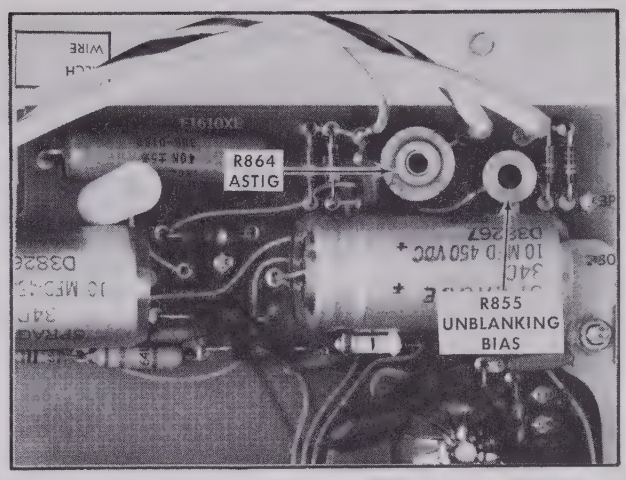



**Fig. 5-6. Location of ASTIG adjustment and unblanking plate Bias adjustment.**

b. Connect the DC voltmeter across R850 using the junction of R850/R845 as one test point and the CRT cathode end of R850 as the other test point (see Fig. 5-5B). The junction of R845/R850 is the most negative.

c. Rotate the RM529 INTENSITY control fully clockwise and defocus the CRT presentation.

d. Calibration Check—Check for a meter reading of 0.15 volts (150 μA).

e. Calibration Adjust—Adjust R848 Beam Current Adjust (see Fig. 5-5C) for a meter reading of 0.15 volts (150 μA).

f. Disconnect the DC voltmeter.

### 5. Adjust ASTIG (R864)

a. Set the DISPLAY switch to 2 LINE.

b. Calibration Check—Check for well-defined display with normal brightness.

c. Calibration Adjust—Adjust the FOCUS and ASTIG control R864 (see Fig. 5-6) to obtain a well-defined display using normal brightness.

### 6. Adjust TRACE ROTATION

a. Set the DISPLAY switch to 2 FIELD.

b. Calibration Check—Check that flat bottoms of the calibrator square waves coincide with the graticule line.

c. Calibration Adjust—Adjust the TRACE ROTATION control (R655; located on front panel) so the flat bottom of the calibrator square waves coincides with the graticule line.

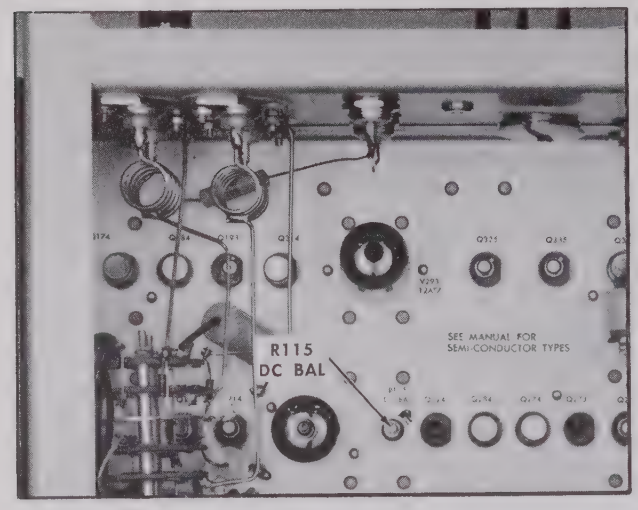



Fig. 5-7. Location of DC BAL adjustment.

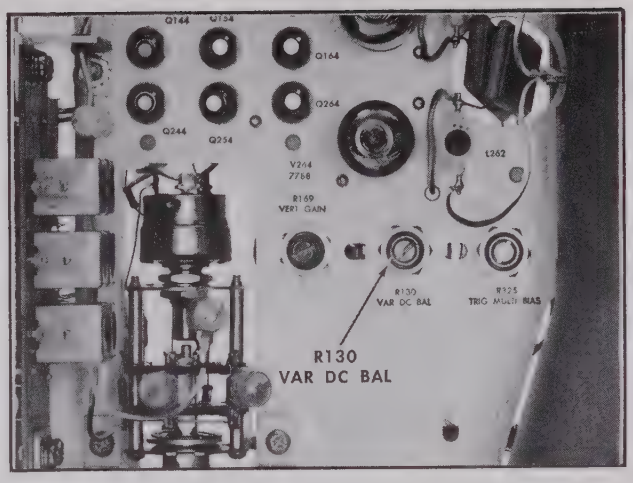



Fig. 5-8. Location of VAR DC BAL adjustment.

### 7. Adjust UNBLANKING PLATE BIAS (R855)

a. Set the INPUT switch to A (no signal applied to VIDEO INPUT A connector).

b. Adjust the INTENSITY control so the CRT trace is barely visible.

c. Calibration Check—Check for uniform intensity along the horizontal axis.

d. Calibration Adjust—Adjust the UNBLANKING PLATE BIAS (R855, see Fig. 5-6) for uniform intensity along the horizontal axis.

### 8. Adjust DC BAL (R115)

a. Set the INPUT switch to A (no signal applied to VIDEO INPUTS A connector).

b. Performance Check—Check for no vertical trace movement as (VERTICAL) VOLTS FULL SCALE switch is changed from 1.0 to 0.2 and 0.5 positions.

c. Calibration Adjust—Adjust DC BAL control R115 (see Fig. 5-7) for no vertical movement of the trace as (VERTICAL) VOLTS FULL SCALE switch is set to 0.2, to 0.5., and then returned to 1.0. Repeat this procedure, if necessary, to check that the adjustment is made properly.

### 9. Adjust VAR DC BAL (R130)

a. Check that the (VERTICAL) VOLTS FULL SCALE switch is set to 1.0.

b. Performance Check—Check for no vertical trace movement as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

c. Calibration Adjust—Adjust VAR DC BAL control R130 (see Fig. 5-8) for no vertical movement of the trace as the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control is rotated from extreme to extreme.

d. Set the (VERTICAL) VARIABLE (VOLTS FULL SCALE) control to the CALIB position.

e. Interaction—Recheck step 8.

## NOTES

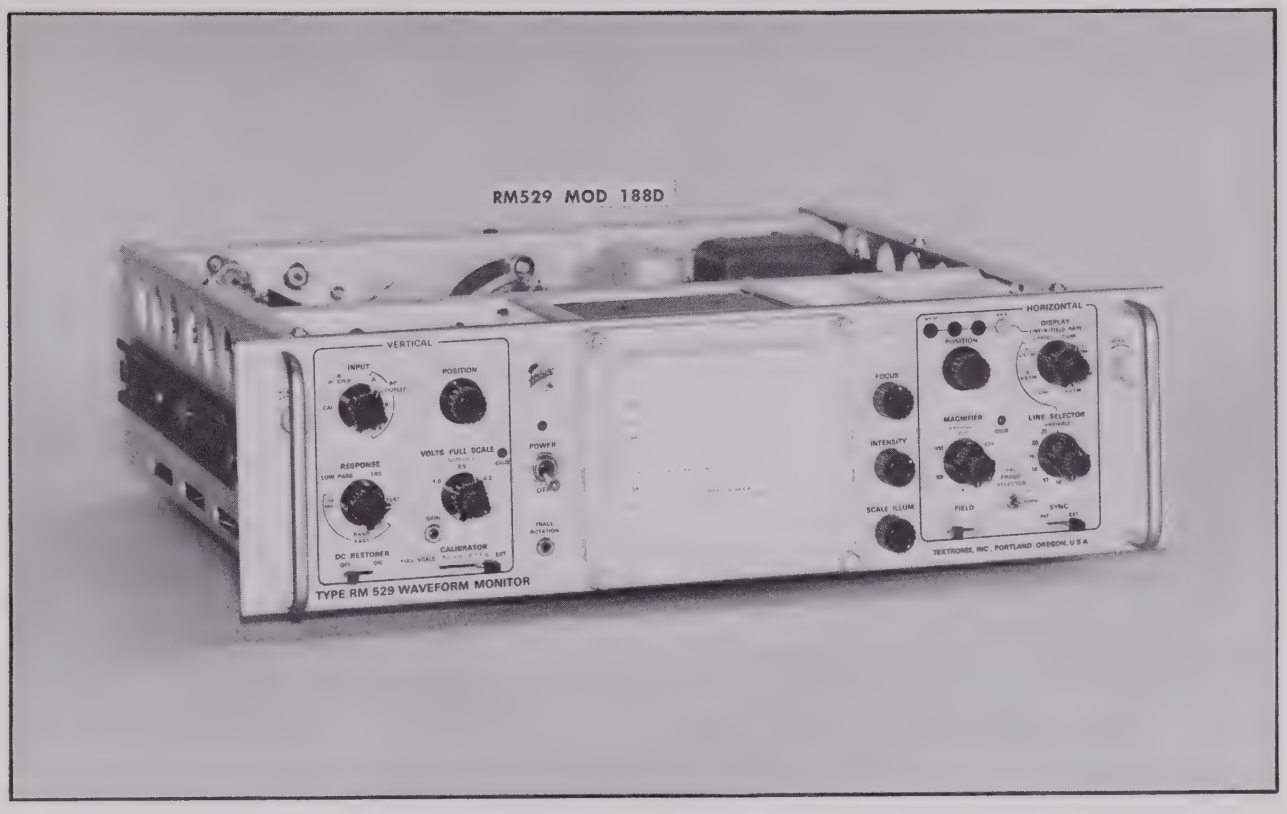



**Fig. 5-9. Test equipment required for steps 10 through 12.**

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| **VERTICAL Controls** | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | CAL |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |

| **CAL** | **FULL SCALE** |
|---|---|
| POSITION | Midrange |
| **HORIZONTAL Controls** | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

## NOTES

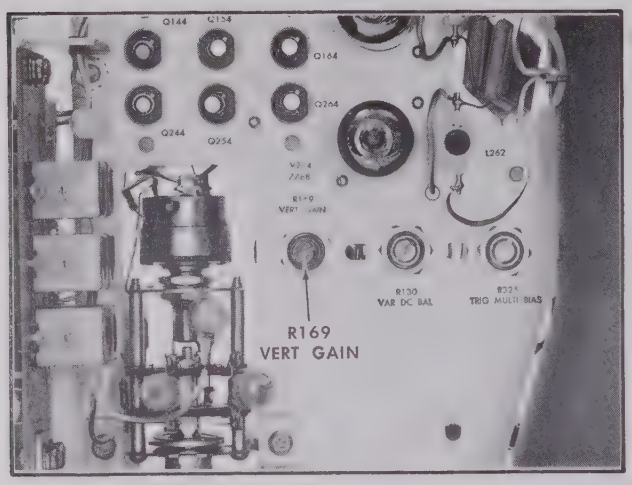



Fig. 5-10. Location of VERT GAIN adjustment.

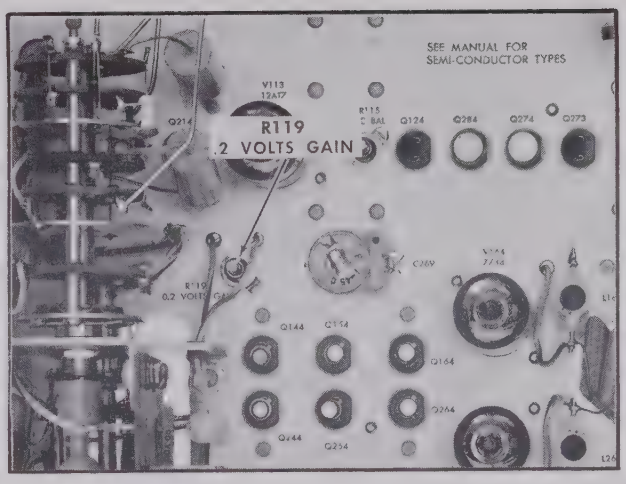



Fig. 5-11. Location of 0.2 VOLTS GAIN adjustment.

### 10. Adjust VERT GAIN (R169)

a. Test equipment setup is shown in Fig. 5-9.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 1.0.

c. Performance/Calibration Check—Adjust VERT GAIN control R169 (see Fig. 5-10) to obtain exactly 140 IRE units of vertical deflection.

### 11. Adjust Vertical 0.2 VOLTS FULL SCALE GAIN (R119)

a. Test equipment setup is given in setup 10.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Performance Check—Check for exactly 140 IRE units of vertical deflection.

d. Calibration Adjust—Adjust 0.2 VOLTS GAIN control R119 (see Fig. 5-11) for exactly 140 IRE units of vertical deflection.

### 12. Check Vertical 0.5 VOLTS FULL SCALE Gain Accuracy

a. Test equipment setup is given in steps 10 and 11.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Performance Check—Check that the vertical deflection of the display is 140 IRE units within a tolerance of ±4 IRE units.

## NOTES

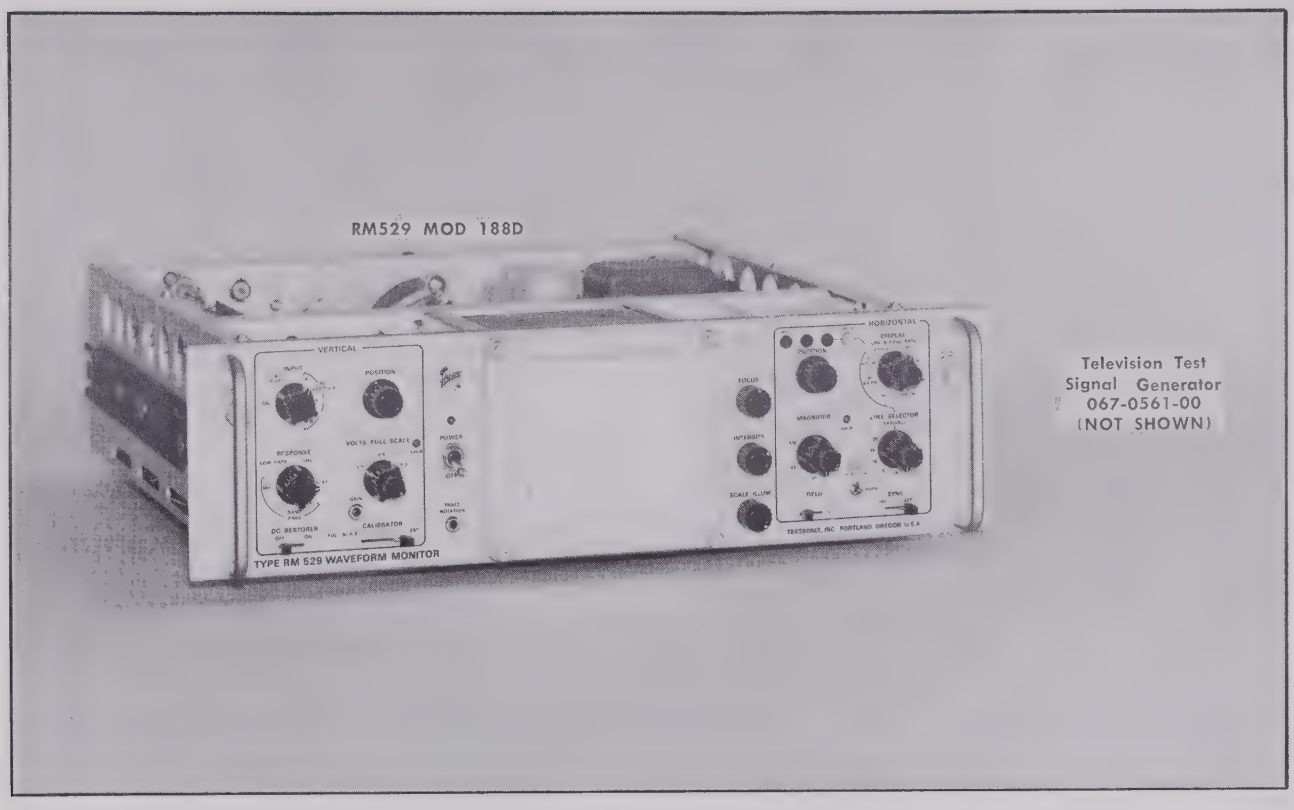



Fig. 5-12. Test equipment required for steps 13, 14, and 15.

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| **VERTICAL Controls** | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| **INPUT** | **A-AC COUPLED** |
| **VOLTS FULL SCALE** | **0.2** |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | FULL SCALE |
| POSITION | Midrange |
| **HORIZONTAL Controls** | |
| POSITION | Midrange |
| SYNC | INT |
| MAG | **X1** |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR | Midrange |
| LINE SELECTOR switch | VARIABLE |
| **LINE & FIELD RATE** | **525/60** |
| PAL FRAME SELECTOR | NORM |

### 13. Adjust TRIG MULTI BIAS (R325)

a. Test equipment setup is shown in Fig. 5-12.

b. Connect a composite video signal to the lower EXT NEG SYNC INPUT connector.

c. Connect a coaxial cable from the upper EXT NEG SYNC INPUT connector to the upper VIDEO INPUTS A connector.

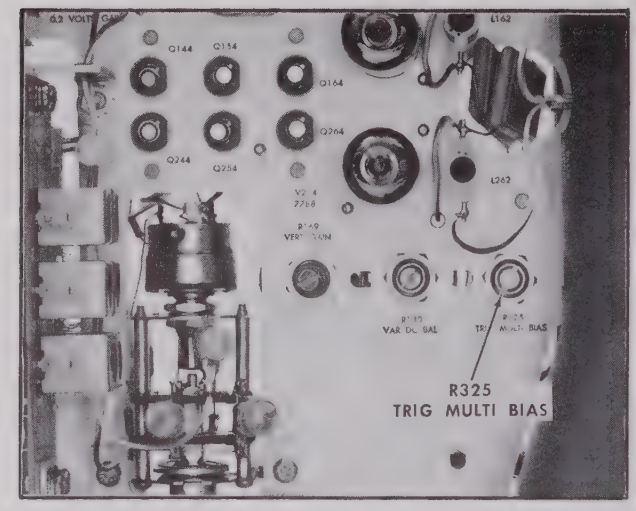



Fig. 5-13. Location of TRIG MULTI BIAS adjustment.

d. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

e. Adjust the source signal level to produce 140 IRE units of composite video.

f. Performance Check—Check for a stable display.

g. Calibration Adjust—Adjust by first rotating TRIG MULTI BIAS control R325 (see Fig. 5-13) fully counterclockwise. Then, rotate the control slowly clockwise until the display is synchronized; that is, a stationary display is obtained. The triggering should also be checked in the other positions of the LINE & FIELD RATE switch (apply appropriate composite video). A slight readjustment may be necessary for proper triggering at all four rates.

NOTE

**If the Type RM529 is used to monitor video signals containing noise, rotate the TRIG MULTI BIAS control about 20° further clockwise from the point where a stable display was first obtained. If the control is turned too far clockwise, a jittery display will be obtained. The control should always be set within the stable display range.**

h. Calibration Check—As a check that the TRIG MULTI BIAS control is properly adjusted, set the (VERTICAL) VOLTS FULL SCALE switch to 1.0, adjust the source signal level for a larger composite video signal amplitude (up to 140 IRE units) and check that the display remains synchronzied.

### 14. Check External Sync

a. Test equipment setup is given in step 12.

b. Set the SYNC switch to EXT.

c. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

d. Adjust the video source signal level so the vertical deflection is 112 IRE units (400 mV p-p) of composite video.

e. Performance Check—Check that a stable display is obtained.

### 15. Check DC RESTORER Switch

a. Test equipment setup is given in step 12.

b. Change the following front-panel controls to settings given.

| | |
|---|---|
| VOLTS FULL SCALE | 1.0 |
| DC RESTORER | ON |
| INPUT | CAL |
| CALIBRATOR | .714 F. S. |
| SYNC | INT |

c. Using the (VERTICAL) POSITION control, position the bottom of the calibrator waveform so it coincides with the 0 (zero) IRE graticule line.

d. Set the INPUT switch to A.

e. Performance Check—Check that the back porch level of the video signal coincides with the 0 IRE graticule line.

f. Set the INPUT switch to CAL.

g. Performance Check—Set the (VERTICAL) VOLTS FULL SCALE switch from 1.0 to 0.2, then to 0.5. Check for ±4 IRE units or less vertical movement of the calibrator waveform from 0 IRE.

h. Set the (VERTICAL) VOLTS FULL SCALE switch to 1.0 and DC RESTORER switch to OFF.

i. Disconnect the video signal from the lower EXT NEG SYNC INPUT connector.

j. Disconnect the jumper coaxial cable.

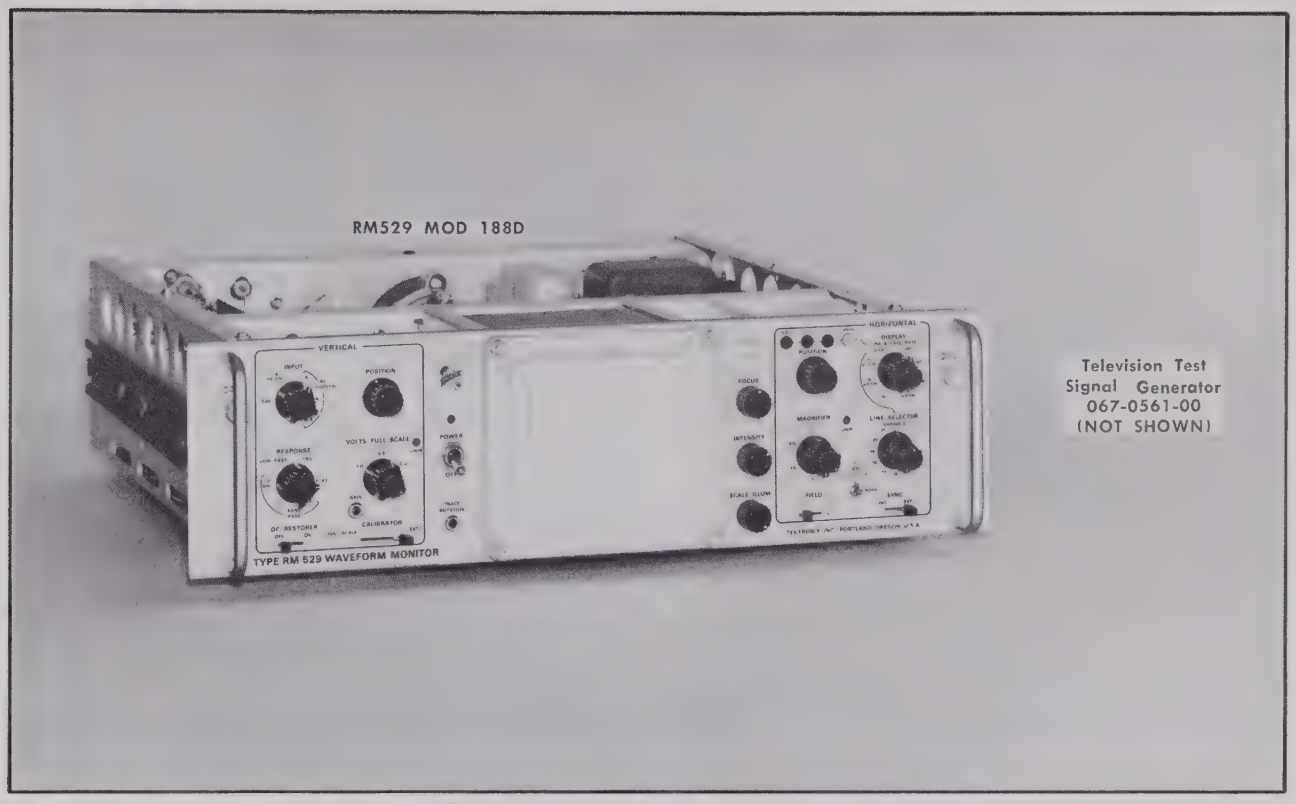



**Fig. 5-14. Test equipment required for steps 16 through 18.**

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| **DC RESTORER** | **OFF** |
| **INPUT** | **A-AC COUPLED** |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CALIBRATOR | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

**16. Adjust HORIZ GAIN (R568) and LINE SWEEP LENGTH (R494)**

a. Test equipment setup is shown in Fig. 5-14.

b. Connect a 525/60 composite video signal to the upper VIDEO INPUTS A connector.

c. Check that the 75-ohm termination is still connected to the lower VIDEO INPUTS A connector.

NOTE

**Use the (VERTICAL) VOLTS FULL SCALE and VARIABLE (VOLTS FULL SCALE) controls to adjust the vertical amplitude of the display in steps 16 through 18.**

d. Calibration Check—Check for a sweep length of 10.2 cm.

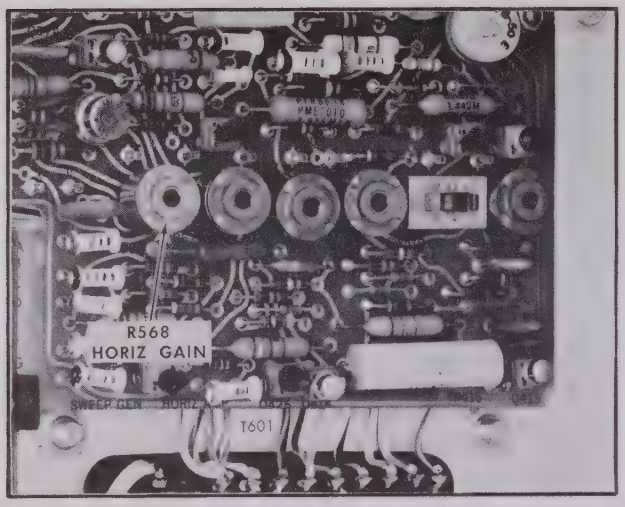



Fig. 5-15. Location of HORIZ GAIN adjustment.

e. Calibration Adjustment/Check—Adjust HORIZ GAIN control R568 (see Fig. 5-15) for a sweep length of 10.2 cm.

Check the sweep length in the 2 FIELD position of the display switch for all positions of the LINE & FIELD RATE switch. Apply composite video signal indicated by LINE & FIELD RATE switch.

f. Set the DISPLAY switch to 2 line.

g. Calibration Check—Check for a sweep length of about 12 cm.

h. Calibration Adjust—Adjust the LINE SWEEP LENGTH control R494 (see Fig. 5-16) for a sweep length of about 12 cm. Check for a stable CRT display.

i. Calibration Check—Check for a sweep length of 9.8 cm to 10.4 cm in the 2 FIELD position of the DISPLAY switch and a minimum sweep length of 9.8 cm in all other positions of the DISPLAY switch. The sweep length is checked to the tolerances above in all positions of the LINE & FIELD RATE switch (applying the appropriate composite video).

j. Interaction—Check step 18.

### 17. Adjust SWP/MAG REGIS (R575) ◐

a. Test equipment setup is given in step 16.

b. Set the MAGNIFIER switch to ×25.

c. Apply a 1 volt 525/60 composite video signal.

d. Using the (HORIZONTAL) POSITION control, position the display so the center of the vertical-sync pulse group coincides with graticule center (see Fig. 5-17).

e. Set the (HORIZONTAL) MAG switch to ×1.

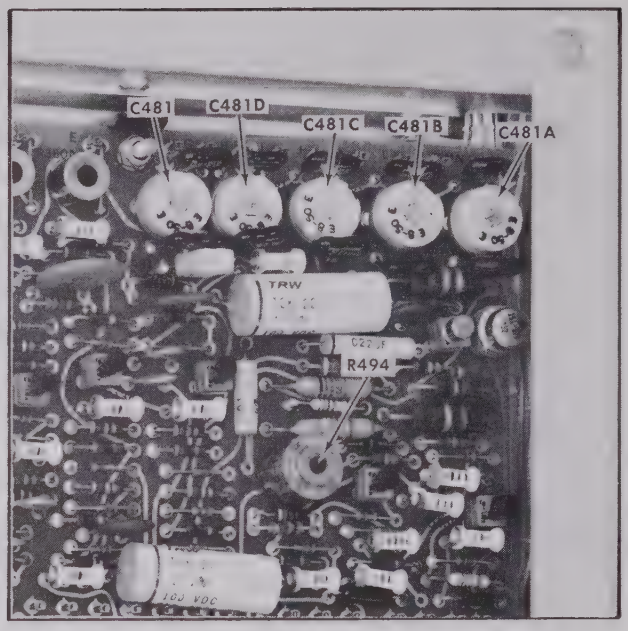



Fig. 5-16. Location of C481, C481A, C481B, C481C, C481D and LINE SWEEP LENGTH, R494 adjustment.

f. Calibration Check—Check that the vertical-pulse group coincides with graticule center (see Fig. 5-17B).

g. Calibration Check—Adjust the SWP/MAG REGIS control (R575). See Fig. 5-18 so the vertical pulse group coincides with graticule center (see Fig. 5-17B).

h. Calibration Check—To check whether the adjustment has been set properly, set the (HORIZONTAL) MAG switch to ×25 and then to ×1. If the display as observed at graticule center shifts horizontally, readjust the SWP/MAG REGIS control (R575) for no horizontal shift on the display when switching from ×25 to ×1.

i. Disconnect the composite video signal.

### 18. Adjust MILLER TIMING CAPACITORS (C481A, B, C & D) ◐

a. Test equipment setup is given in step 16.

b. Set the front-panel controls to these settings:

| | |
|---|---|
| DISPLAY | 1 LINE |
| LINE & FIELD RATE | 405/50 |

c. Apply 405/50 composite video.

d. Calibration Check—Check for 10 cm between horizontal sync pulses, ±3%.

e. Calibration Adjust—Adjust C481A (see Fig. 5-16) for 10 cm between horizontal sync pulses, ±3%.

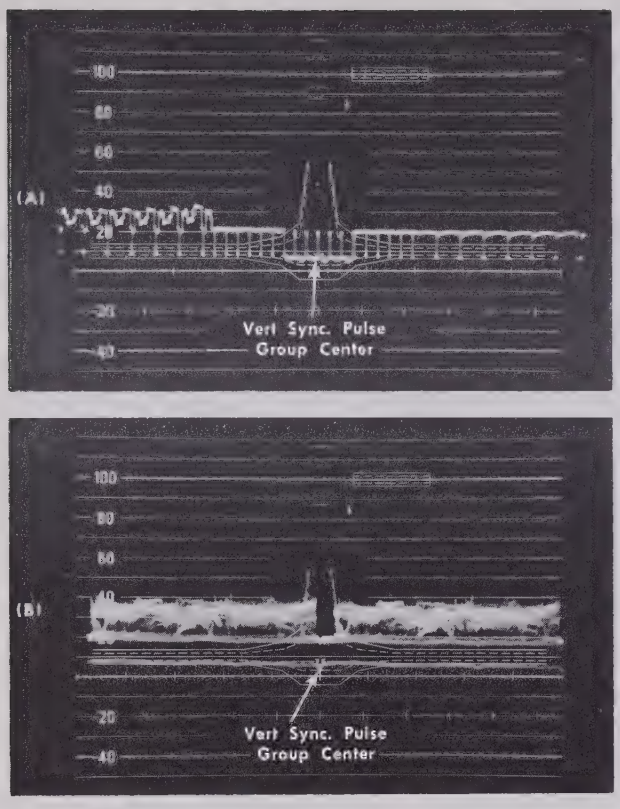



**Fig. 5-17. Adjusting the SWP/MAG REGIS control (R575) for proper display registration. The Horizontal MAGNIFIER was set to (A) X25 (B) X1.**

f. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third horizontal sync pulses, ±3%.

g. Interaction—Check step 16.

h. Test equipment setup is given in step 16.

i. Set the front-panel controls to these settings:

| | |
|---|---|
| DISPLAY | 1 LINE |
| LINE & FIELD RATE | 525/60 |

j. Apply 525/60 composite video.

k. Calibration Check—Check for 10 cm between horizontal sync pulses, ±3%.

l. Calibration Adjust—Adjust C481B (see Fig. 5-16) for 10 cm between horizontal sync pulses, ±3%.

m. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third horizontal sync pulses, ±3%.

n. Interaction—Check step 16.

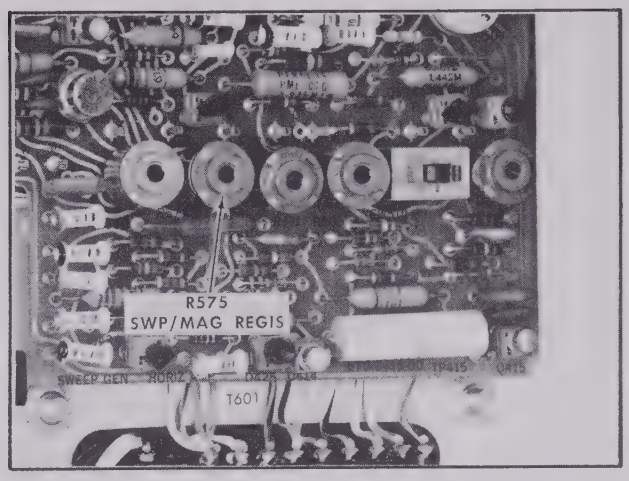



**Fig. 5-18. Location of SWP/MAG REGIS adjustment.**

o. Test equipment setup is given in step 16.

p. Set the front-panel controls to these settings:

| | |
|---|---|
| DISPLAY | 1 LINE |
| LINE & FIELD RATE | 625/50 |

q. Apply 625/50 compsoite video.

r. Calibration Check—Check for 10 cm between horizontal sync pulses, ±3%.

s. Calibration Adjust—Adjust C481C (see Fig. 5-16) for 10 cm between horizontal sync pulses, ±3%.

t. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third horizontal sync pulses, ±3%.

u. Interaction—Check step 16.

v. Test equipment setup is given in step 16.

w. Set the front-panel controls to these settings:

| | |
|---|---|
| DISPLAY | 1 LINE |
| LINE & FIELD RATE | 819/50 |

x. Apply 819/50 composite video.

y. Calibration Check—Check for 10 cm between horizontal sync pulses, ±3%.

z. Calibration Adjust—Adjust C481D (see Fig. 5-16) for 10 cm between horizontal sync pulses, ±3%.

aa. Change DISPLAY switch to 2 LINE and check for 10 cm between the first and third horizontal sync pulses, ±3%.

bb. Interaction—Check step 16.

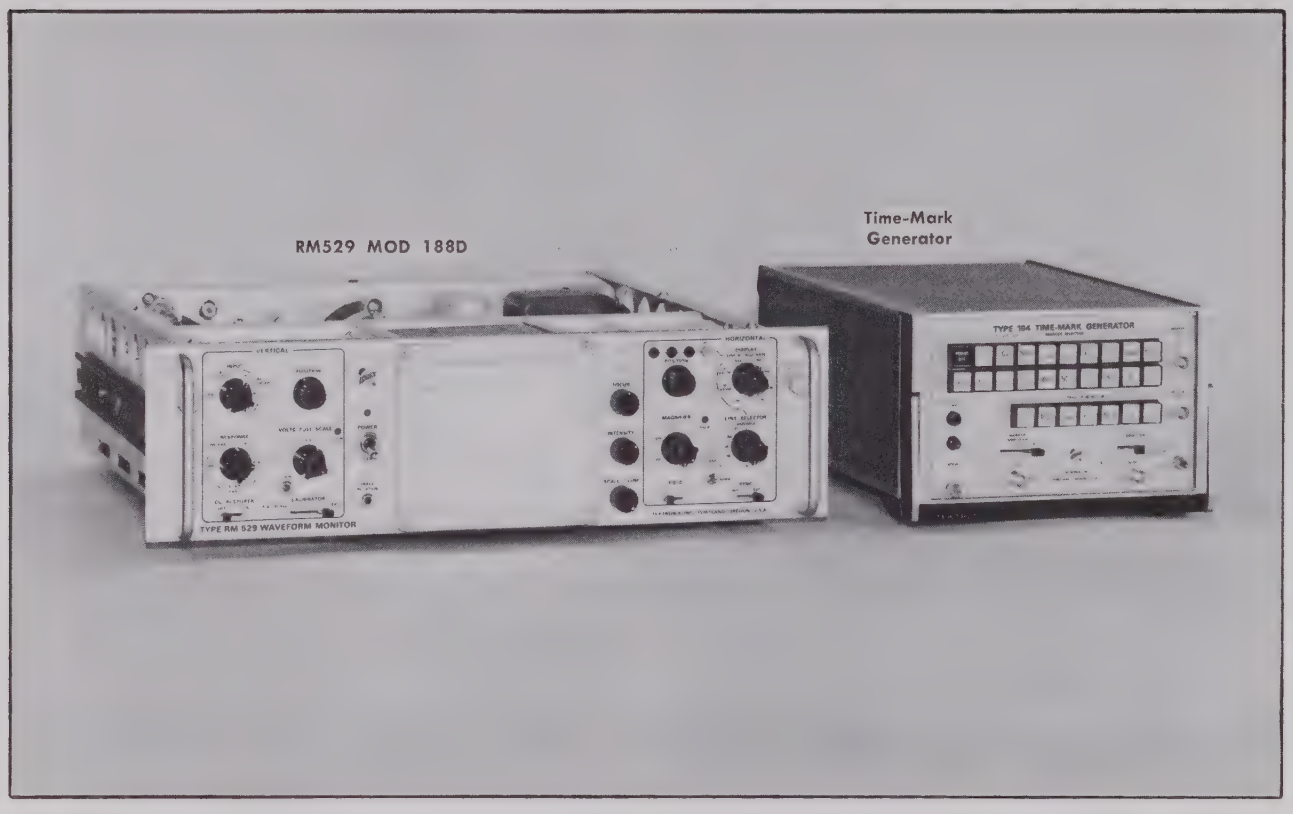



**Fig. 5-19. Test equipment required for step 19.**

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 FIELD |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| **LINE & FIELD RATE** | **525/60** |
| PAL FRAME SELECTOR | NORM |

**19. Check ×1 Sweep Timing**

a. Test equipment setup is shown in Fig. 5-19.

b. Connect 1 μs time markers from the time-mark generator to the upper VIDEO INPUTS A connector.

c. Check that the 75-ohm termination is still connected to the lower VIDEO INPUTS A connector.

d. Connect 100 ms triggers from the time-mark generator to the upper EXT NEG SYNC INPUT connector.

e. Set the front-panel controls to these settings:

| | |
|---|---|
| LINE & FIELD RATE | 405/50 |
| DISPLAY | 1 LINE |
| SYNC | EXT |

f. Performance Check—Check for a sweep rate of 9.875 μs/cm (9 each 10 μs markers, not counting the first marker, plus 8¾ each 1 μs markers in 10 cm), ±3%.

g. Performance Check—Change the DISPLAY switch to 2 LINE and check for a sweep rate of 19.75 μs/cm (19 each 10 μs markers plus 7½ each 1 μs markers in 10 cm), ±3%.

h. Change LINE & FIELD RATE switch to 525/60 and DISPLAY switch to 1 LINE.

i. Performance Check—Check for a sweep rate of 6.35 μs/cm (6 each 10 μs markers plus 3½ each 1 μs markers in 10 cm), ±3%.

j. Performance Check—Change the DISPLAY switch to 2 LINE and check for a sweep rate of 12.7 μs/cm (12 each 10 μs markers plus 7 each 1 μs markers in 10 cm), ±3%.

k. Change LINE & FIELD RATE switch to 625/50 and DISPLAY switch to 1 LINE.

l. Performance Check—Check for a sweep rate of 6.4 μs/cm (6 each 10 μs markers plus 4 each 1 μs markers in 10 cm), ±3%.

m. Performance Check—Change the DISPLAY switch to 2 LINE and check for a sweep rate of 12.8 μs/cm (12 each 10 μs markers plus 8 each 1 μs markers in 10 cm), ±3%.

n. Change LINE & FIELD RATE switch to 819/50 and DISPLAY switch to 1 LINE.

o. Performance Check—Check for a sweep rate of 4.893 μs/cm (4 each 10 μs markers plus 9 each 1 μs markers in 10 cm), ±3%.

p. Performance Check—Change the DISPLAY switch to 2 LINE and check for a sweep rate of 9.876 μs/cm (9 each 10 μs markers plus 8 each 1 μs markers in 10 cm), ±3%.

q. Any of the above ×1 sweep rate checks found to exceed its ±3% limit will require readjustment of the appropriate Miller timing capacitor in step 18.

## NOTES

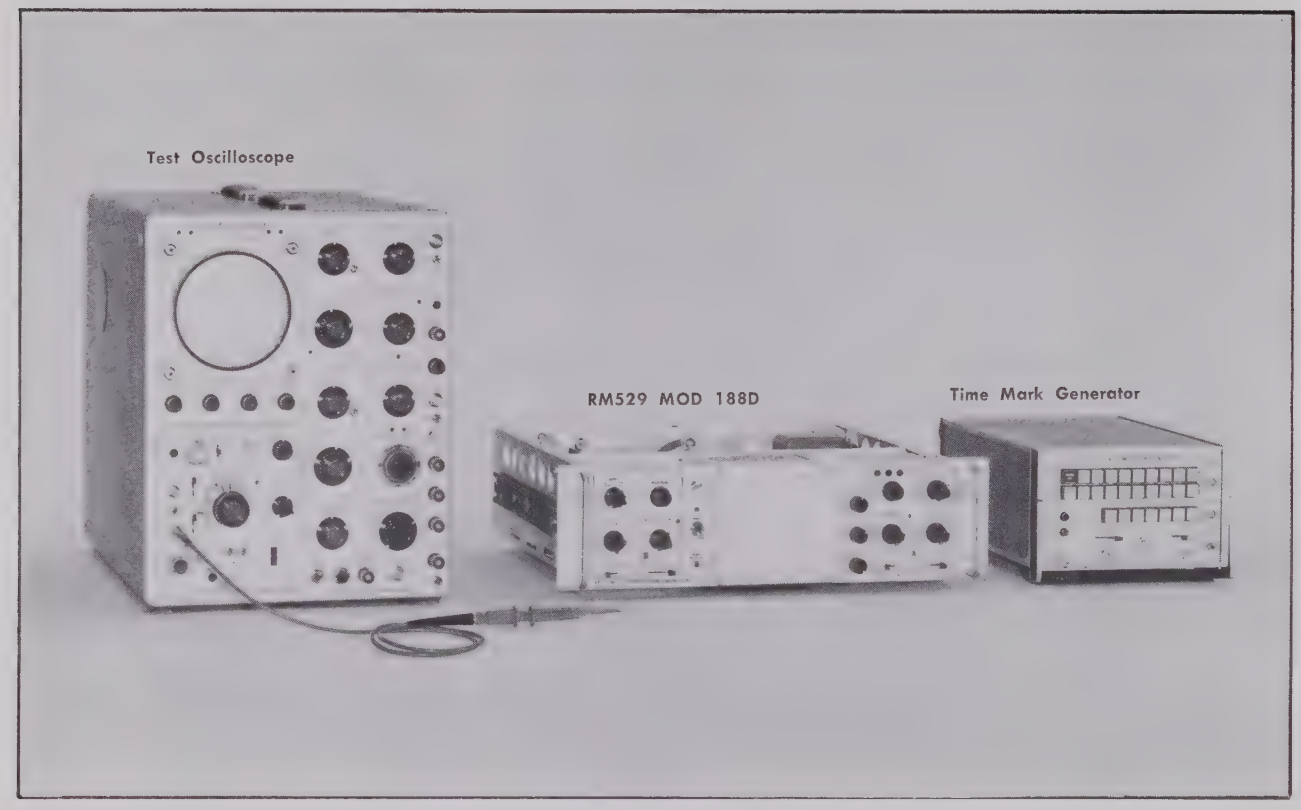



Fig. 5-20. Test equipment required for steps 20 through 24.

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| **DISPLAY** | **2 FIELD** |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| **LINE & FIELD RATE** | **525/60** |
| PAL FRAME SELECTOR | NORM |

### 20. Adjust Miller Timing Capacitor C481

a. Test equipment setup is given in Fig. 5-20.

b. Connect the time-mark generator trigger output to the test oscilloscope trigger input.

c. Connect the test oscilloscope +Gate output to the EXT NEG SYNC INPUT connector on the RM529 MOD 188D.

d. Set the time-mark generator for 5 μs time markers and 10 μs triggers.

e. Trigger the test oscilloscope on the 10 μs triggers with the time/div set to 5 μs/cm.

f. Set the DISPLAY switch to 5 μs/cm.

g. Calibration Check—Check for 50 μs of sweep time in 10 cm, ±3%.

h. Calibration Adjust—Adjust Miller Timing Capacitor (see Fig. 5-16) for 50 μs of sweep time in 10 cm, ±3%.

i. Change the DISPLAY switch to 10 μs/cm.

j. Calibration Check—Check for 100 μs of sweep time in 10 cm, ±3%.

k. A slight readjustment of Miller Timing Capacitor C481 may be necessary to obtain correct timing in both the 5 μS/CM and 10 μS/CM positions of the DISPLAY switch.

### 21. Check ×5 and ×10 Magnified Sweep Timing

a. Test equipment setup is given in step 20.

b. Set the front-panel controls to these settings:

| | |
|---|---|
| DISPLAY | 5 μS/CM |
| MAGNIFIER | ×5 |

c. Set the time-mark generator for 1 μs time markers and 10 μs triggers.

d. Performance Check—Check for 10 μs of sweep time in 10 cm, ±3%.

e. Performance Check—Change the DISPLAY switch to 10 μS/CM and check for 20 μs of sweep time in 10 cm, ±3%.

f. Set the time-mark generator for .5 μs time markers.

g. Performance Check—Change the MAGNIFIER to ×10 and check for 10 μs of sweep time in 10 cm, ±4%.

h. Performance Check—Change the DISPLAY switch to 5 μS/CM and check for 5 μs of sweep time in 10 cm, ±4%.

### 22. Adjust ×20 Magnified Sweep Timing (C527-R528)

a. Test equipment setup is given in step 20.

b. Set the front panel controls to these settings:

| | |
|---|---|
| MAGNIFIER | ×20 |
| DISPLAY | 10 μS/CM |

c. Set the time-mark generator for .5 μs time-markers and 10 μs triggers.

d. Calibration Check—Check for 5 μs of sweep time in 10 cm, ±5%.

e. Calibration Adjust—Adjust R528 (see Fig. 5-21) for 5 μs of sweep time in 10 cm (10 each .5 μs time-markers), ±5%.

f. Calibration Check—Change the DISPLAY switch to 5 μS/CM and check for 2.5 μs of sweep time in 10 cm, ±5%.

g. Calibration Adjust—Adjust C527 (see Fig. 5-21) for best linearity between pulses and check for 5 each 0.5 μs pulses in 10 cm, ±5%.

h. There is interaction between C527 and R528.

### 23. Adjust ×25 Magnified Sweep Timing (C523-R524)

a. Test equipment setup is given in step 20.

b. Set the front panel controls to these settings:

| | |
|---|---|
| MAGNIFIER | ×25 |
| DISPLAY | 10 μS/CM |

c. Set the time-mark generator for .5 μs time-markers and 10 μs triggers.

d. Calibration Check—Check for 4 μs of sweep time in 10 cm, ±5%.

e. Calibration Adjust—Adjust R524 (see Fig. 5-21) for 4 μs of sweep time in 10 cm, ±5%.

f. Calibration Check—Change the DISPLAY switch to 5 μS/CM and check for 2 μs of sweep time in 10 cm, ±5%.

g. Calibration Adjust—Adjust C523 (see Fig. 5-21) for best linearity between time marks and check for 2 μs of sweep time in 10 cm, ±5%.

h. There is interaction between C523 and R524.

### 24. Check MAGNIFIER VARIABLE control R557.

a. Test equipment setup is given in step 20.

b. Set the front panel controls to these settings:

| | |
|---|---|
| DISPLAY | 5 μS/CM |
| MAGNIFIER | ×5 |

c. Set the time-mark generator for 5 μs time markers and 10 μs triggers.

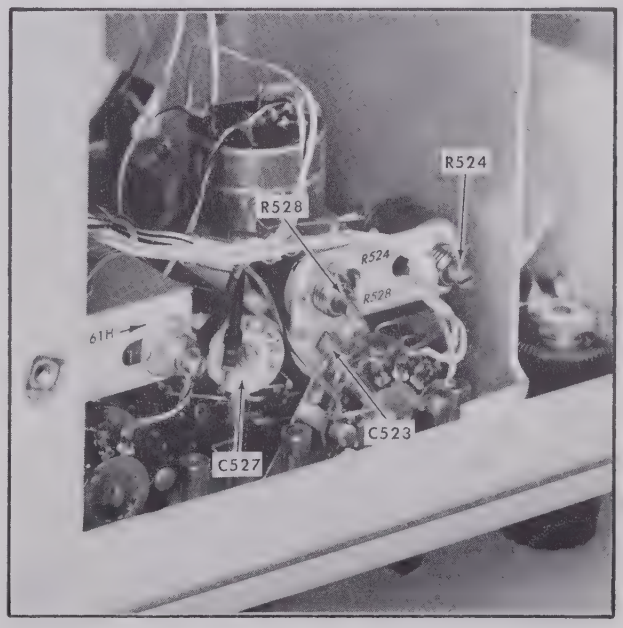



Fig. 5-21. Location of R528, R524, C527, and C523.

d. Rotate the MAGNIFIER VARIABLE control counterclockwise only far enough to remove the switch from the detent position.

e. Performance Check—Check for 8 μs or less of sweep time in 10 cm.

f. Performance Check—Rotate the MAGNIFIER VARIABLE control fully counterclockwise and check for 12 μs or more of sweep time in 10 cm.

g. Performance Check—Check to see that the CALIB neon is not lit any time the MAGNIFIER VARIABLE control is out of the detent (CALIB) position.

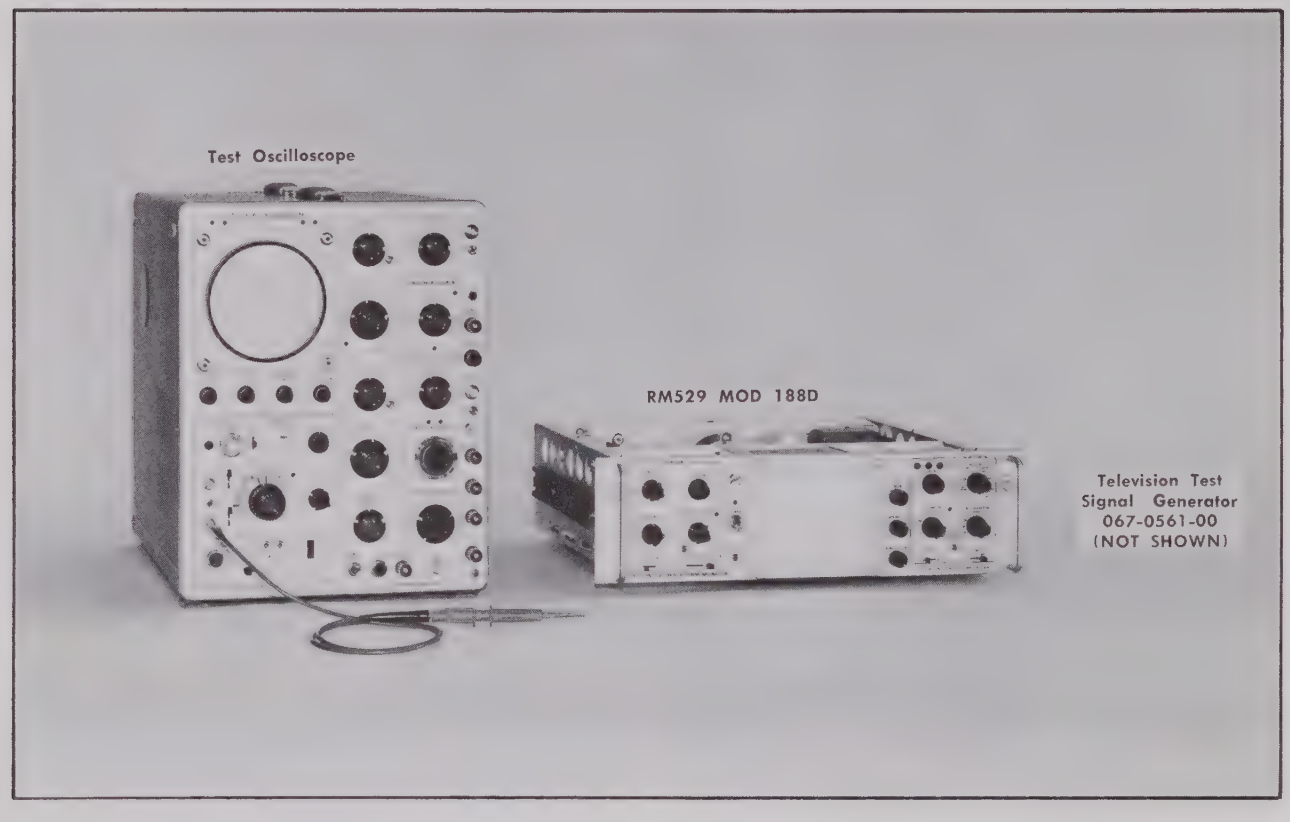



Fig. 5-22. Test equipment required for steps 25 and 26.

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | ON |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F.S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| **MAGNIFIER** | **×25** |
| MAGNIFIER VARIABLE | CALIB |
| **DISPLAY** | **2 FIELD** |
| FIELD | TWO |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| **LINE & FIELD RATE** | **405/50** |
| PAL FRAME SELECTOR | NORM |

**25. Adjust FIELD 1 SYNC (R360A, R360B, R360C and R360D)**

a. Test equipment setup is given in Fig. 5-22.

b. Set the test oscilloscope controls as follows:

| | |
|---|---|
| Sweep Rate | 50 μs/cm |
| Triggering | + Ext, AC |
| Signal Input Coupling | AC |
| Vertical Deflection Factor (with 10× attenuator probe) | 5 Volts/cm |

c. Connect a 10× probe from the vertical input connector to the junction of D370 and C370 (TP370, see Fig. 5-23).

d. Connect a 1× probe from the external trigger input connector to the junction of D377 and D387 (TP377, see Fig. 5-23).

e. Connect a 1 volt 405/50 composite video signal to the upper VIDEO INPUTS A connector.

f. Check that a 75 ohm termination is connected to the lower VIDEO INPUTS A connector.

g. Calibration Adjust—The 405/50 television system has a vertical block of eight pulses only. Adjust 405/50 FIELD 1 SYNC adjust R306A, (see Fig. 5-23) to position the vertical ramp immediately behind the eight vertical serration.

h. Calibration Adjust—Readjust R360A until the first horizontal sync pulse is superimposed about half way down the ramp, keeping away from the critical points on either side where the ramp tends to latch up on either adjacent pulse (see Fig. 5-24A).

i. Change the LINE & FIELD RATE switch to 525/60.

j. Apply a 1 volt 525/60 composite video signal.

k. Calibration Adjust—Adjust 525/60 FIELD 1 SYNC adjust, R360B, (see Fig. 5-22) so the ramp starts just after the sixth equalizing pulse (see Fig. 5-24B).

l. Change the LINE & FIELD RATE switch to 625/60.

m. Apply a 1 volt 625/50 composite video signal.

n. Calibration Adjust—Adjust 625/50 Field 1 Adjust R260C, (see Fig. 5-23) so the ramp starts just after the fifth equalizing pulse (see Fig. 5-24C).

o. Change the LINE & FIELD RATE switch to 819/50.

p. Apply a 1 volt 819/50 composite video signal.

q. Calibration Adjust—Adjust 819/50 Field 1 Sync Adjust R360D (see Fig. 5-23) so the ramp starts just after the seventh equalizing pulse (see Fig. 5-24D).

## NOTES

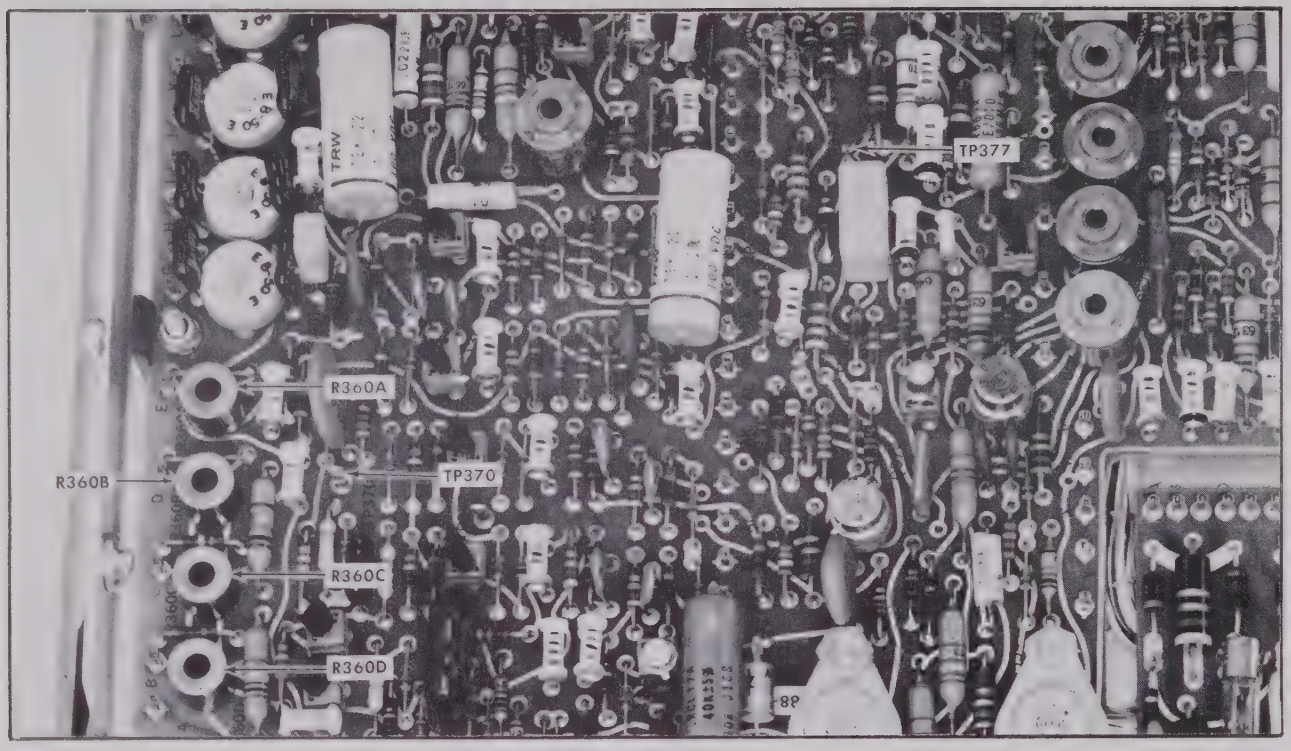
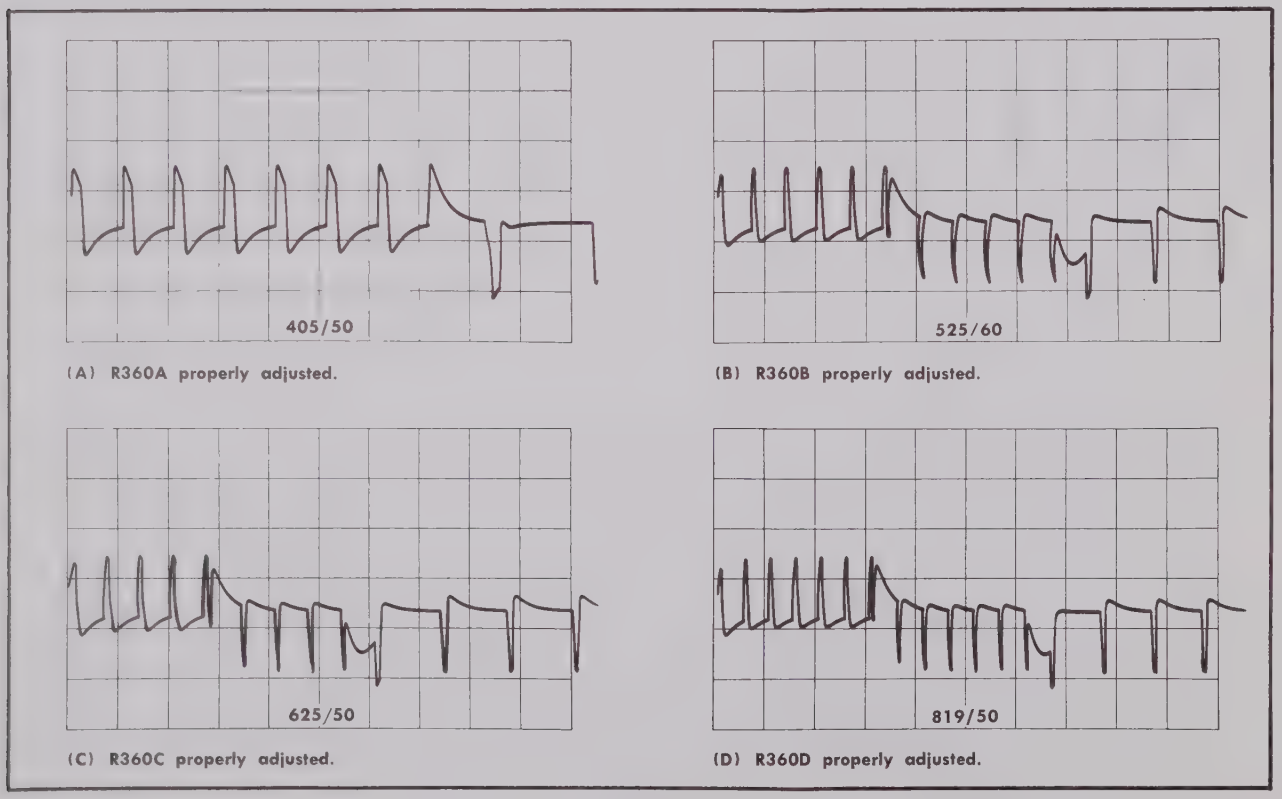



Fig. 5-23. Location of TP370, TP377, R360A, R360B, R360C and R360D.




(A) R360A properly adjusted.

(B) R360B properly adjusted.

(C) R360C properly adjusted.

(D) R360D properly adjusted.

Fig. 5-24. Field 1 Sync waveforms.

**26. Check FIELD switch.**

a. Test equipment setup is given in step 25.

b. Apply a 1 volt 405/50 composite video signal.

NOTE

**If vertical sync pulse is not completely displayed, position it to the horizontal center of the viewing area with the (HORIZONTAL) POSITION control.**

c. Performance Check—Check for a horizontal distance of 1 H between the last horizontal sync pulse and the first vertical serration (see Fig. 5-25A). This indicates that field 1 is displayed at the center of the CRT.

d. Performance Check—Set the SYNC switch to EXT and back to INT several times to check that a field display is obtained each time the SYNC switch is returned to the INT position. This is a double check on step 25. A stable display of field 1 means that R360A is adjusted properly.

e. Set the FIELD switch to ONE.

f. Performance Check—Check for 0.5 H horizontal distance between the last horizontal sync pulse and the first vertical serration (see Fig. 5-25B). This indicates that field 2 is displayed at the center of the CRT.

g. Performance Check—Repeat part d, except check that a field 2 display is obtained each time the SYNC switch is returned to INT.

h. Performance Check—Repeat steps b through h for each position of the LINE & FIELD RATE switch (apply appropriate composite video). Any instability in field selection will indicate a need to readjust the appropriate Field 1 Sync adjustment given in step 25.

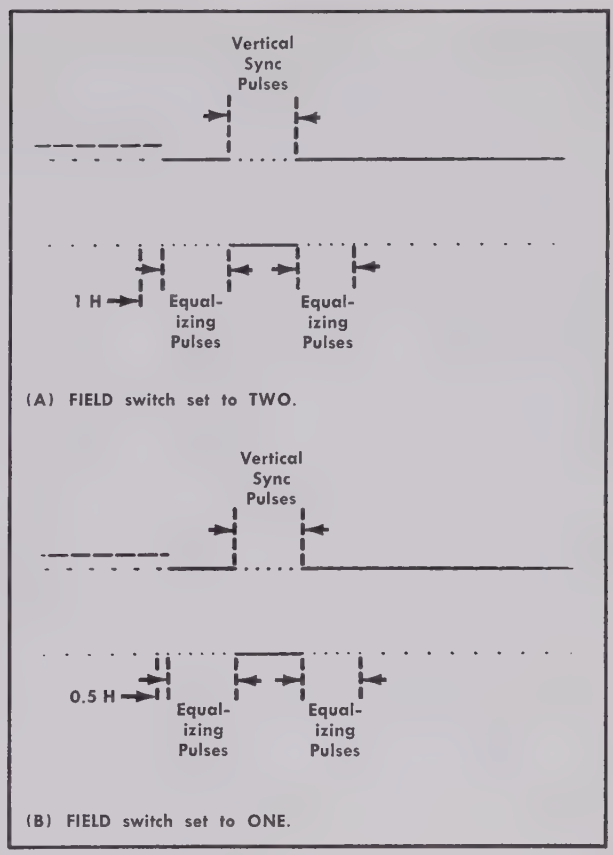



**Fig. 5-25. Checking for proper field display when operating the FIELD and SYNC switches.**

## NOTES

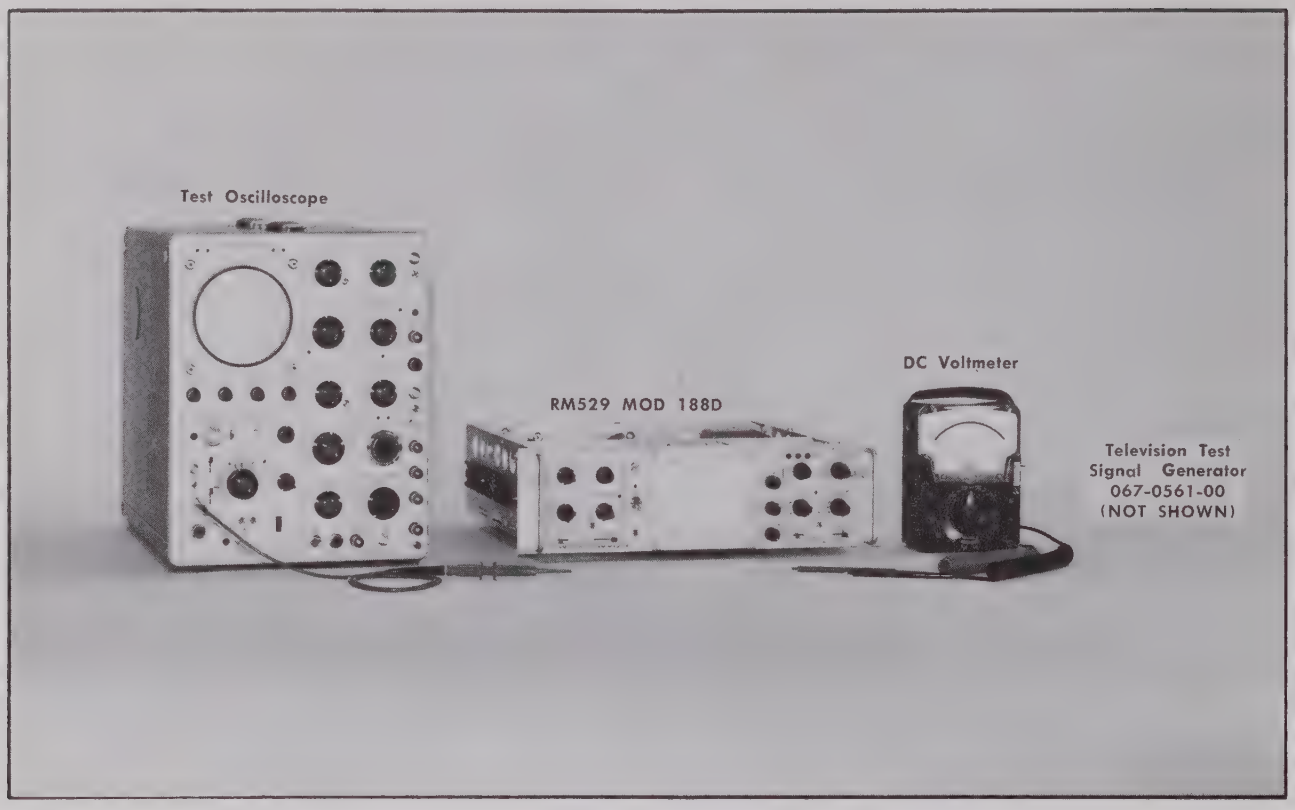



Fig. 5-26. Test equipment required for steps 27 through 31.

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| **MAGNIFIER** | **×1** |
| MAGNIFIER VARIABLE | CALIB |
| **DISPLAY** | **LINE SELECTOR 1 LINE** |
| **FIELD** | **TWO** |
| VARIABLE (LINE SELECTOR) | Midrange |
| **LINE SELECTOR switch** | **21** |
| **LINE & FIELD RATE** | **525/60** |
| PAL FRAME SELECTOR | NORM |

### 27. Check Line Selector Brightening Pulse Amplitude

a. Test equipment setup is shown in Fig. 5-26.

b. Apply one volt of 525/60 composite video to the upper VIDEO INPUTS A connector.

c. Connect a 75-ohm termination to the lower VIDEO INPUTS A connector.

d. Connect a 75-ohm coaxial cable from the VIDEO OUTPUT connector of the Type RM529 to the vertical input connector of the test oscilloscope.

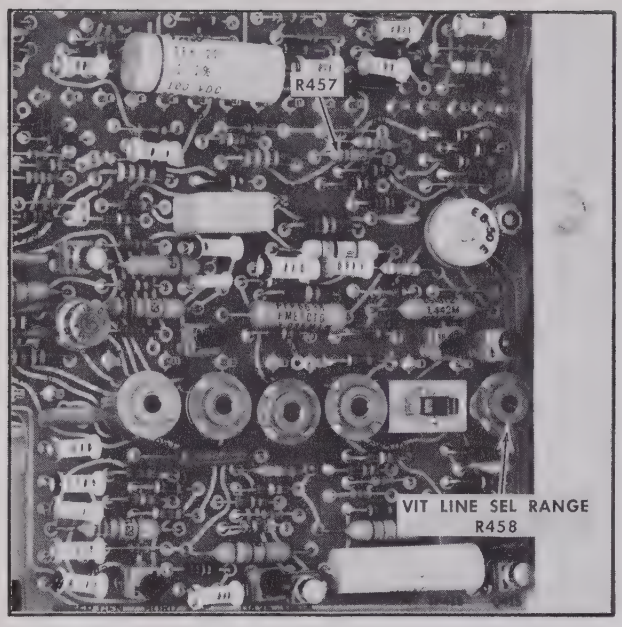



Fig. 5-27. Location of VIT LINE SEL RANGE control R458 and R457.

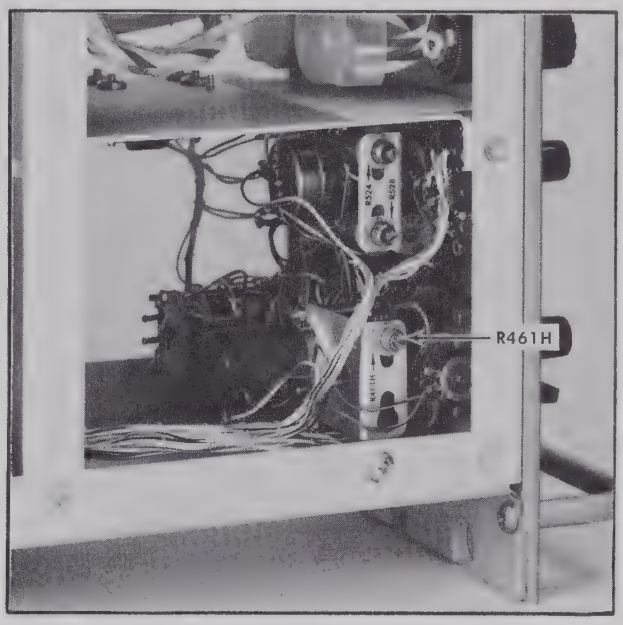



Fig. 5-28. Location of R461H.

e. Connect a 1× probe from the appropriate Trigger Input connector of the test oscilloscope to the junction of D377 and D387 (TP377, see Fig. 5-23).

f. Set the test oscilloscope controls as follows:

| | |
|---|---|
| Input Selector | AC |
| Volts/Div | 0.02 |
| Time/Div | 2 ms |
| Triggering Mode | Adjusted for stable Display |
| Trigger Slope | + External |

g. Performance Check—Check that the brightening pulse amplitude is at least 100 mV high.

### 28. Adjust VIT LINE SEL RANGE (R458 and R461H)

a. Test equipment setup is given in step 27.

b. Connect a DC voltmeter between the center arm of R458 and ground (See Fig. 5-27).

c. Apply a 1 volt 525/60 composite video signal to the upper VIDEO INPUTS A connector.

d. Calibration Adjust—Adjust VIT LINE SEL RANGE control R458 (see Fig. 5-27) so the brightening pulse just starts to jump between the 21st and 22nd lines as observed on the test oscilloscope.

NOTE

**In the 525/60 television system, LINE 10 starts at the first horizontal pulse following the last equalizing pulse. Lines 16 through 21 can be found by counting forward from this point of reference.**

e. Note the DC voltmeter reading.

f. Calibration Adjust—Adjust VIT LINE SEL RANGE control R458 so the brightening pulse just starts to jump between the 21st and 20th lines as observed on the test oscilloscope.

g. Note the DC voltmeter reading.

h. Calibration Adjust—Adjust VIT LINE SEL RANGE control R458 for a DC voltmeter reading halfway between the two readings noted in parts e and g of this step.

i. Disconnect the DC voltmeter.

j. Change the LINE & FIELD RATE switch to 625/50.

k. Apply a 1 volt 625/50 composite video signal to the upper VIDEO INPUTS A connector.

l. Adjust R461H (see Fig. 5-28) so the brightening pulse is on line 16.

## NOTES

NOTE

**In the CCIR 625/50 television system, LINE 6 starts at the first horizontal pulse following the last equalizing pulse. Lines 16 through 21 can be found by counting forward from this point of reference.**

**29. Check Line Selector Operation.**

a. Test equipment setup is given in step 27.

b. Apply a 1 volt 525/60 composite video signal to the upper VIDEO INPUTS A connector.

c. Set the LINE SELECTOR switch to VARIABLE and rotate the VARIABLE (LINE SELECTOR) control fully counterclockwise.

d. Performance Check—Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must start on or before the 20th line.

NOTE

**In the 525/60 television system, LINE 10 starts at the first horizontal pulse following the last equalizing pulse.**

e. Rotate the VARIABLE (LINE SELECTOR) control fully clockwise.

f. Performance Check—Check the position (in time) of the brightening pulse on the test oscilloscope. The brightening pulse must be at least 25% into the second field.

g. Set the LINE SELECTOR switch to each numbered line position.

h. Calibration Check—Check that the brightening pulse starts at the start of the line to which the LINE SELECTOR switch is set.

i. Performance Check—Set the FIELD switch to ONE and repeat parts c through h.

j. Set the front-panel controls to these settings:

| | |
|---|---|
| LINE & FIELD RATE | 625/50 |
| FIELD | TWO |

k. Apply a 1 volt 625/50 composite video signal to the upper VIDEO INPUTS A connector.

l. Performance Check—Set the LINE SELECTOR to VARIABLE and repeat steps c through i.

NOTE

**In the CCIR 625/50 television system, LINE 6 starts at the first horizontal pulse following the last equalizing pulse.**

m. Disconnect the composite video signal and the test oscilloscope from the Type RM529 MOD 188D.

**30. Check PAL FRAME SELECTOR switch.**

a. Test equipment setup is given in step 27.

b. Set the front-panel controls to these settings:

| | |
|---|---|
| LINE & FIELD RATE | 625/50 |
| DISPLAY | 2 FIELD |
| PAL FRAME SELECTOR | EITHER EXTREME POSITION |

c. Connect a 1× probe from the appropriate External Trigger Input connector to test point TP377.

d. Connect a 10× probe from the test oscilloscope input connector to test point TP474.

e. Set the test oscilloscope controls as follows:

| | |
|---|---|
| Input Selector | AC |
| Volts/Div | .05 |
| Time/Div | 10 msec |
| Triggering Mode | For a stable display |
| Triggering Slope | + External |

f. Rotate the test oscilloscope Variable Time/Div control so three complete unblanking waveforms are displayed.

g. Set the PAL FRAME SELECTOR switch to the opposite extreme position.

h. Performance Check—Check the unblanking waveform displayed on the test oscilloscope for equal amplitude and shape but opposite in polarity as the PAL FRAME SELECTOR switch is moved from one extreme to the other.

i. Remove the 1× and 10× probes from the RM529 MOD 188D.

**31. Check A DC COUPLED position of Vertical INPUT switch**

a. Test equipment setup is given in step 27.

b. Apply a 1 volt 525/60 composite video signal to the upper VIDEO INPUTS A connector with INPUT set to A-AC COUPLED.

c. Set the DC RESTORER switch to the ON position.

d. Vertically position the trace to the center of the graticule.

e. Performance Check—Change the INPUT selector switch to A-DC COUPLED and check for no trace shift.

f. Set the DC RESTORER switch to the OFF position.

g. Performance Check—Check for trace movement to the DC level of the input signal.

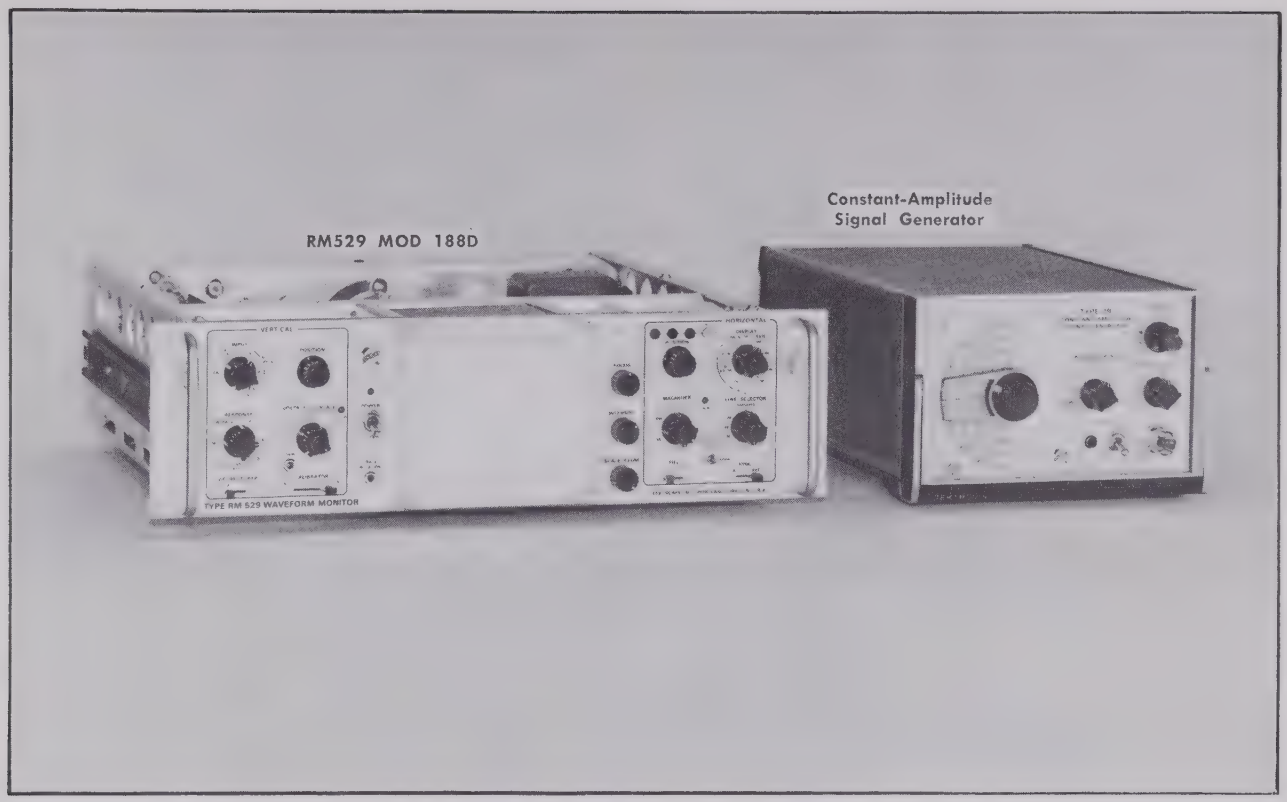



**Fig. 5-29. Test equipment required for steps 32 through 40.**

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | Midrange |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | OFF |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| **DISPLAY** | **2 FIELD** |
| **FIELD** | **ONE** |
| VARIABLE (LINE SELECTOR) | Midrange |
| **LINE SELECTOR switch** | **VARIABLE** |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

### 32. Check Vertical Amplifier Frequency Response

a. Test equipment setup as shown in Fig. 5-29.

b. Apply a 50 kHz sine-wave signal from the constant amplitude sine-wave generator to the VIDEO INPUT A connector.

c. Adjust the constant amplitude sine-wave generator for 100 IRE units of vertical deflection; this is the reference amplitude.

d. Performance Check—Follow the remaining sequence of instructions given in Table 5-2 to check the vertical-amplifier frequency response and rolloff for all the front-panel control positions listed.

**33. Adjust Vertical-Amplifier 1.0 Flat-Frequency Response (C269, L162 and L262)**

a. Test equipment setup is given in step 32.

b. Performance Check—Check the vertical-amplifier response from 500 kHz to 8 MHz. It should be flat within +0%, —1% to 6 MHz, +0%, —3% to 8 MHz.

c. Calibration Adjust—Adjust the vertical amplifier components (see Fig. 5-30) as listed in Table 5-3 to obtain flat frequency response from 500 kHz to 8 MHz within +0%, —1% to 6 MHz and flat to within +0%, —3% to 8 MHz.

d. Calibration Check—Recheck the response between 500 kHz and 8 MHz at several points to determine if any of the adjustments in this step need to be readjusted to obtain the desired response.

TABLE 5-2

Checking Vertical Amplifier Frequency Response

| RESPONSE Switch Set To: | Signal[1] To: INPUT Switch Set To: | VARIABLE (VOLTS FULL SCALE) Set To: | (VERTICAL) VOLTS FULL SCALE Switch Set To: | Check or Procedure |
|---|---|---|---|---|
| FLAT | A AC COUPLED | CALIB | 1.0 | Check the frequency response from 500 kHz to 8 MHz[2]; must be flat within +0%, —1% (—0.1 dB) or 1 IRE unit to 6 MHz, +0%, —3% (—0.3 dB) or 3 units to 8 MHz. |
| | | | 0.2 | Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz. |
| | | | 0.5 | Check the frequency response from 500 kHz to 6 MHz[3]; must be flat within +3%, —3% (±0.3 dB) or 3 IRE units. |
| | B AC COUPLED | CALIB | 1.0 | Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz. Check the frequency response from 500 kHz to 8 MHz; must be flat within +0%, —1% (—0.1 dB) to 5 MHz, +0%, —3% (—0.3 dB) to 8 MHz. |
| LOW PASS | A AC COUPLED | CALIB | 1.0 | Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz. Check for vertical deflection of 20 units or less at 500 kHz. |
| FLAT | A AC COUPLED | CALIB | 0.2 | [4]Set the constant amplitude sine-wave generator for 50 IRE units of reference amplitude at 50 kHz. |
| 1.10 MHz BANDPASS | A AC COUPLED | CALIB | 0.2 | Check for 100 IRE units of vertical deflection at 1.096 MHz. Check for 90 IRE units or more of vertical deflection at 0.9 and 1.3 MHz and for 12.5 IRE units or less at 200 kHz. |
| FLAT | A AC COUPLED | CALIB | 1.0 | [4]Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz. |
| 3.58 MHz BANDPASS | A AC COUPLED | CALIB | 1.0 | Check for 100 IRE units of vertical deflection at 3.58 MHz. Check for 65 to 85 IRE units of vertical deflection at 3.18 MHz and 3.98 MHz. |
| FLAT | A AC COUPLED | CALIB | 0.2 | [4]Set the constant amplitude sine-wave generator for 50 IRE units of reference amplitude at 50 kHz. |
| 4.43 MHz BANDPASS | A AC COUPLED | CALIB | 0.2 | Check for 100 IRE units of vertical deflection at 4.43 MHz. Check for 65 to 85 IRE units of vertical deflection at 3.93 and 5.13 MHz. |

**[1]Apply the signal to the upper VIDEO INPUT connector as indicated in the column and terminate the appropriate lower VIDEO INPUT connector with a 75-ohm termination.**

**[2]If frequency response cannot be obtained within the tolerance specified, perform step 32 before completing the checks given in the remaining portion of Table 5-2.**

**[3]If frequency response within the tolerance cannot be obtained for the 0.2 and 0.5 vertical VOLTS FULL SCALE switch position, perform step 34 for the 0.2 position and step 35 for 0.5.**

**[4]This is a preliminary setup procedure for performing the frequency- response check that follows.**

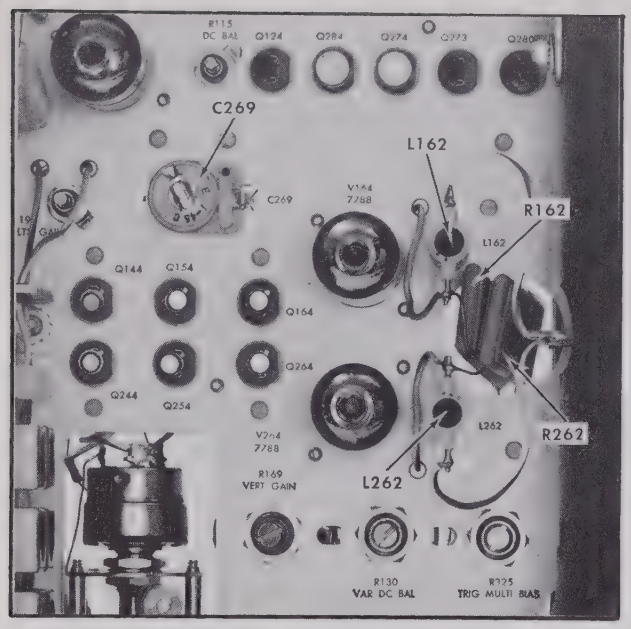



Fig. 5-30. Location of C269, R162, R262, L162 and L262.

TABLE 5-3

Vertical Amplifier Flat-Frequency Response Adjustments Shown in Fig. 5-31

| Adjustment | Affects Frequency Response in These Frequency Ranges |
|---|---|
| C269 | 2 to 6 MHz, particularly at 2.5 MHz |
| Physical spacing of R162 and R262 | 3 to 6 MHz, particularly at 4 MHz |
| L162 and L262 Slugs | 5 to 10 MHz |

### 34. Adjust Vertical-Amplifier 0.5 Flat-Frepuency Response (C118B)

a. Test equipment setup is given in step 32.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.5.

c. Set the constant-amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz.

d. Performance Check—Check for a frequency response flat within +0%, —1% from 500 kHz to 6 MHz.

e. Calibration Adjust—Adjust C118B (see Fig. 5-31) to obtain frequency response from 500 kHz to 6 MHz flat within +0%, —1%.

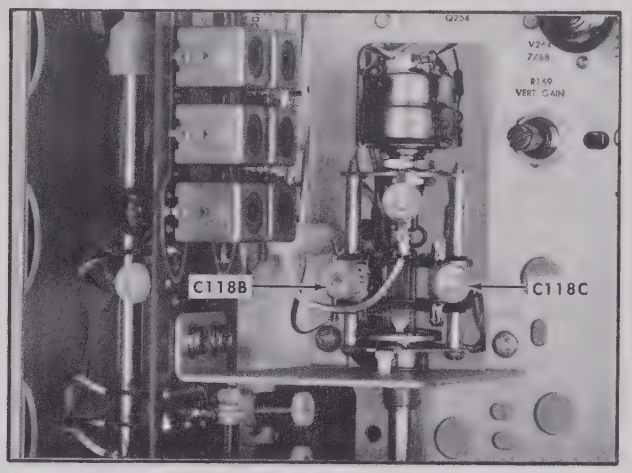



Fig. 5-31. Location of C118B and C118C.

### 35. Adjust Vertical-Amplifier 0.2 Flat-Frequency Response (118C)

a. Test equipment setup is given in step 32.

b. Set the (VERTICAL) VOLTS FULL SCALE switch to 0.2.

c. Set the constant-amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz.

d. Performance Check—Check for a frequency response flat within +0%, —1% 500 kHz to 6 MHz.

e. Calibration Adjust—Adjust C118C (see Fig. 5-31) to obtain frequency response from 500 kHz to 6 MHz flat within +0%, —1%.

### 36. Adjust Common Mode Rejection (C119)

a. Test equipment setup is given in step 32.

b. Disconnect the constant-amplitude sine-wave generator from the A VIDEO INPUT connector.

c. To the constant-amplitude sine-wave generator 50 ohm GR to BNC termination connect a female to female BNC adapter and a BNC T connector to the female to female BNC adapter. Connect a 75 ohm coaxial cable from one end of the T connector to the upper A VIDEO INPUT connector. Connect another 75 ohm coaxial cable from the other end of the T connector to the upper B VIDEO INPUT connector.

d. Connect a 75 ohm termination to the lower B VIDEO INPUT connector.

e. Set the VOLTS FULL SCALE switch to 1.0.

f. Apply 40 IRE units of 2 MHz signal from the constant-amplitude sine-wave generator to the Type RM529 MOD 188D.

g. Set the INPUT switch to A-B.

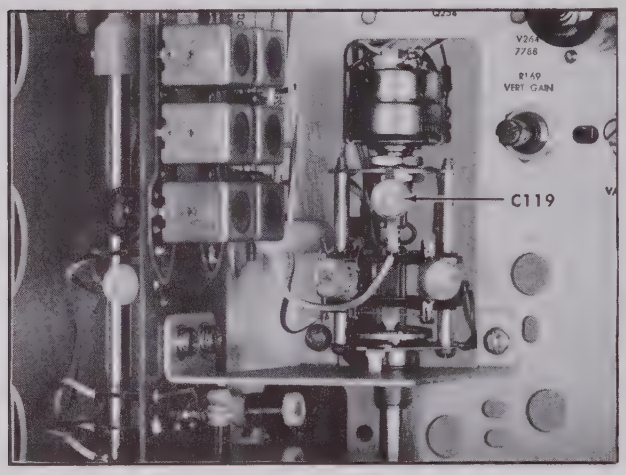



Fig. 5-32. Location of C119.

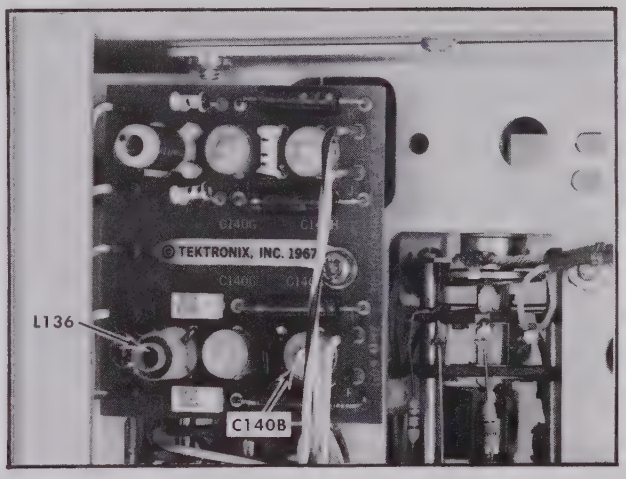



Fig. 5-33. Location of C140B, and L136.

h. Calibration Adjust—Adjust C119 (see Fig. 5-32) for minimum display amplitude. If desired, the VOLTS FULL SCALE switch may be set to provide a larger signal.

i. Calibration Check—Recheck steps 31 through 34 and this step several times to eliminate any interaction.

j. Remove the female BNC adapter, the BNC T connector and the two 75 ohm cables. Remove the 75 ohm termination from the lower B VIDEO INPUT connector and reconnect the constant-amplitude sine-wave generator to the upper A VIDEO INPUT connector.

### 37. Adjust Vertical Amplifier 1.10 MHz Frequency Response (L136 and C140B)

a. Test equipment setup is given in step 32.

b. Set the RESPONSE switch to FLAT and the VOLTS FULL SCALE switch to 0.2.

c. Set the constant amplitude sine-wave generator for 50 IRE units of reference amplitude at 50 kHz.

d. Set the constant amplitude sine-wave generator for an output frequency of 1.096 MHz.

e. Set the RESPONSE switch to 1.10 MHz.

f. Performance Check—Check for 100 IRE units of vertical deflection.

g. Calibration Adjust--Adjust L136, and C140B (see Fig. 5-33) to obtain 100 IRE units of vertical deflection (interaction).

h. Set the constant amplitude sine-wave generator for an output frequency of 1.3 MHz.

i. Calibration Check—Check for 90 IRE units or more of vertical deflection.

j. Set the constant amplitude sine-wave generator for an output frequency of 0.9 MHz.

k. Calibration Check—Check for 90 IRE units or more of vertical deflection.

l. Set the constant amplitude sine-wave generator for an output frequency of 200 kHz.

m. Calibration Check—Check for 12.5 IRE units or less of vertical deflection.

n. Calibration Adjust—If necessary, repeat adjustment of L136 and C140B to obtain proper frequency response characteristics.

### 38. Adjust Vertical Amplifier 3.58 MHz Frequency Response (C239, L138 and L238)

a. Test equipment setup is given in step 32.

b. Set the RESPONSE switch to FLAT and the VOLT FULL SCALE switch to 1.0.

c. Set the constant-amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz.

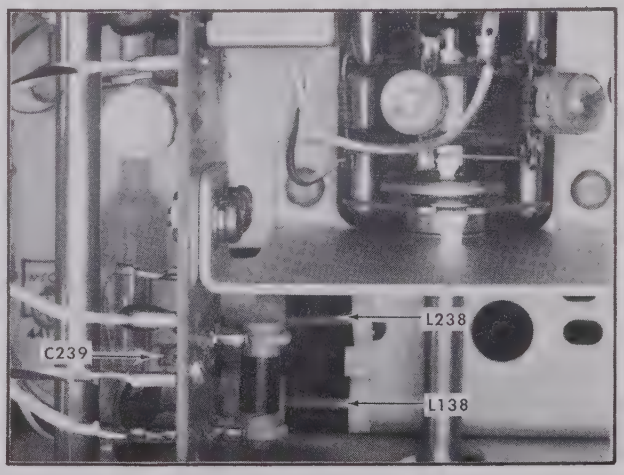



Fig. 5-34. Location of C239, L138 and L238.

d. Set the constant-amplitude sine-wave generator for an output frequency of 3.58 MHz.

e. Set the RESPONSE switch to 3.58 MHz.

f. Performance Check—Check for 100 IRE units of vertical deflection.

g. Calibration Adjust—Adjust C239, L138 and L238 (see Fig. 5-34) to obtain 100 IRE units of vertical deflection.

h. Set the constant amplitude sine-wave generator for an output frequency of 3.98 MHz.

i. Calibration Check—Check for 65 to 85 IRE units of vertical deflection.

j. Set the constant amplitude sine-wave generator for an output frequency of 3.18 MHz.

k. Calibration Check—Check for 65 to 85 IRE units of vertical deflection.

l. Calibration Adjust—If necessary, repeat adjustment of C239, L138 and L238 to obtain proper frequency response characteristics.

### 39. Adjust Vertical Amplifier 4.43 MHz Frequency Response (C140G and C140H)

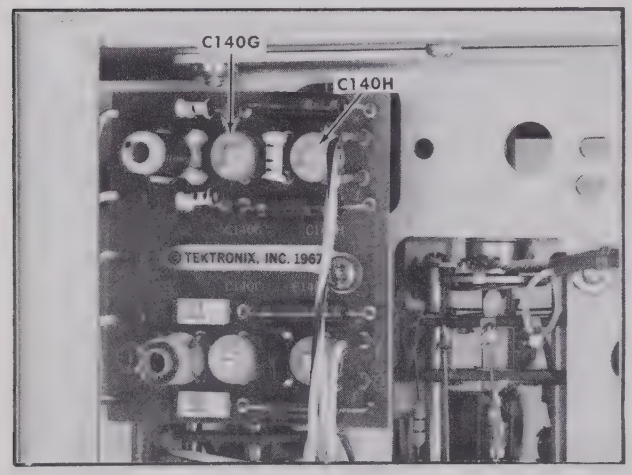



**Fig. 5-35. Location of C140H andC140G.**

a. Test equipment setup is given in step 32.

b. Set the RESPONSE switch to FLAT and the VOLTS FULL SCALE to 0.2.

c. Set the constant amplitude sine-wave generator for 50 IRE units of reference amplitude at 50 kHz

d. Set the constant amplitude sine-wave generator for an output frequency of 4.43 MHz.

e. Set the RESPONSE switch to 4.43 MHz.

f. Performance Check—Check for 100 IRE units of vertical deflection.

g. Calibration Adjust—Adjust C140G and C140H (see Fig. 5-35) to obtain 100 IRE units of vertical deflection.

h. Set the constant amplitude sine-wave generator for an output frequency of 5.13 MHz.

i. Calibration Check—Check for 65 to 85 IRE units of vertical deflection.

j. Set the constant amplitude sine-wave generator for an output frequency of 3.93 MHz.

k. Calibration Check—Check for 65 to 85 IRE units of vertical deflection.

l. Calibration Adjust—If necessary, repeat adjustment of C140G and C140H to obtain proper frequency response characteristics.

### 40. Adjust Vertical Amplifier LOW PASS Frequency Response (L135, L235, L134, L234, L133, L233, C232)

a. Test equipment setup is shown in step 32.

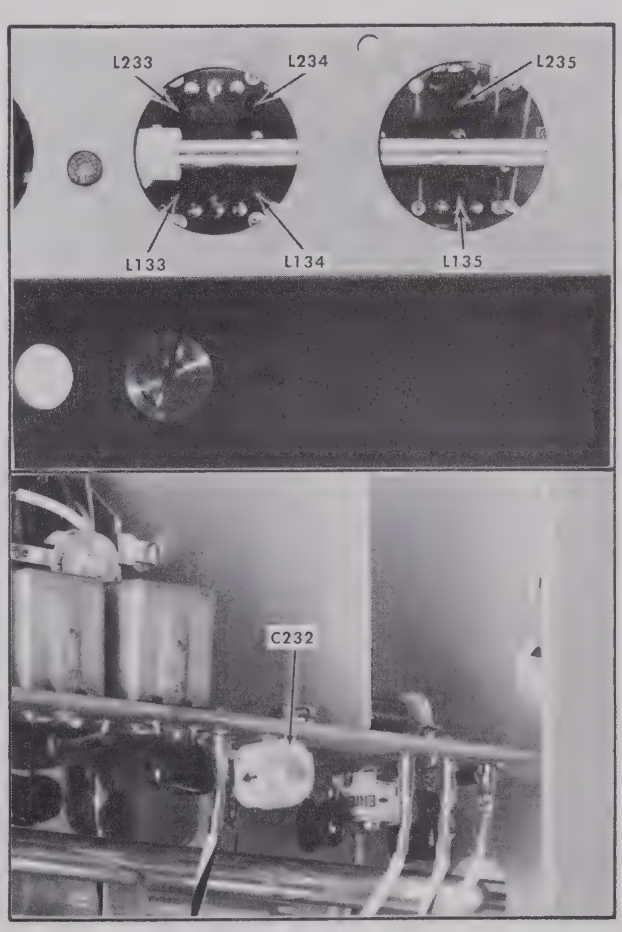



**Fig. 5-36. Location of L135, L235, L134, L234, L133, L233, (B) C232.**

b. Set the RESPONSE switch to LOW PASS and the INPUT switch to CAL.

c. Performance Check—Check for good square corner on the leading edge of the calibrator signal waveform.

d. Calibration Adjust—Adjust in the following sequence, L135, L235, L134, L234, L133, L233 and C232 (see Fig. 5-36) for the best square corner on leading edge of the calibrator signal waveform.

e. Set the INPUT switch to A-AC COUPLED.

f. Set the constant amplitude sine-wave generator for 100 IRE units of reference amplitude at 50 kHz.

g. Set the constant amplitude sine-wave generator for an output frequency of 500 kHz.

h. Calibration Check—Check for 25 IRE units or less of vertical deflection.

i. After completing all of the LOW PASS frequency reponse adjustments and the checks in Table 5-2, disconnect the constant amplitude sine-wave generator from the Type RM529 MOD 188D.

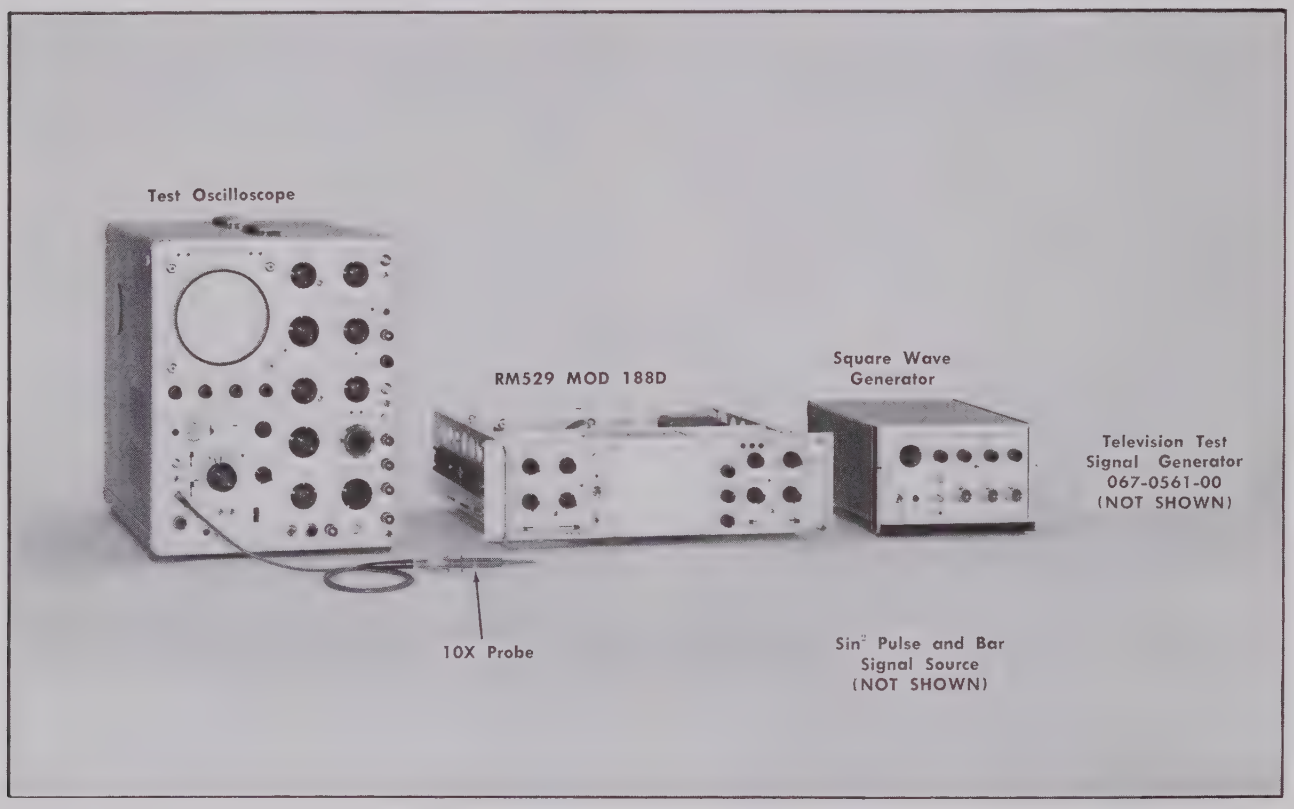

Test Oscilloscope
RM529 MOD 188D
Square Wave Generator
Television Test Signal Generator 067-0561-00 (NOT SHOWN)
10X Probe
Sin² Pulse and Bar Signal Source (NOT SHOWN)

**Fig. 5-37. Test equipment required for steps 41 and 42.**

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjusted for normal display brightness |
| GAIN | As is |

VERTICAL Controls

| | |
|---|---|
| RESPONSE | FLAT |
| DC RESTORER | ON |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |

HORIZONTAL Controls

| | |
|---|---|
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| **DISPLAY** | **2 LINE** |
| FIELD | ONE |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

**41. Adjust Staircase Amplifier Compensations (R511, C507, and R505)**

a. Test equipment setup is shown in Fig. 5-37.

b. Wire the 9-pin plug connector (Tektronix Part No. 134-0049-00) as shown in Fig. 5-38.

c. Connect the plug to J501 on the Type RM 529 MOD 188D.

d. Apply a one volt of composite video to the upper VIDEO INPUTS A connector.

e. Connect a 75 ohm termination to the lower VIDEO INPUTS A connector.

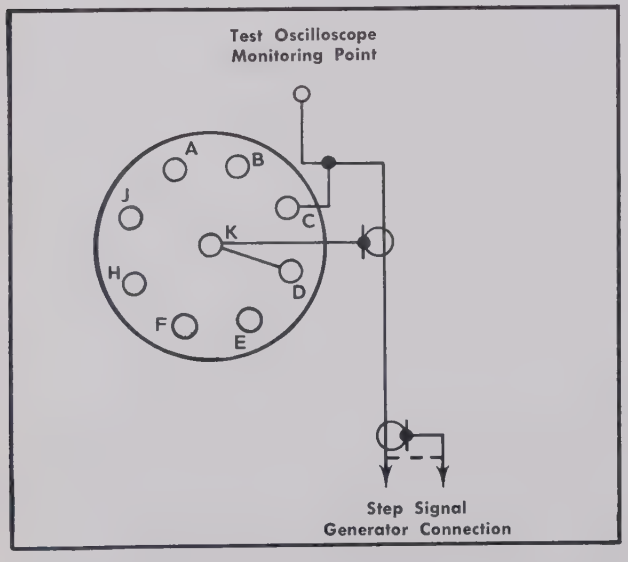



**Fig. 5-38. Front view of 9-pin plug connector (Tektronix Part No. 134-0049-00) showing jumper wire connections to cause relay K385 to be energized whenever the plug is in place.**

f. Calibration Adjust—Center the display with OUTPUT LEVEL control R511 (see Fig. 5-39).

g. Performance Check—Check for a display trace length of 2.5 cm or less if STAIRCASE SELECTOR switch SW510 is set for YRGB display, (3.3 cm or less if STAIRCASE SELECTOR switch SW510 is set for RGB display).

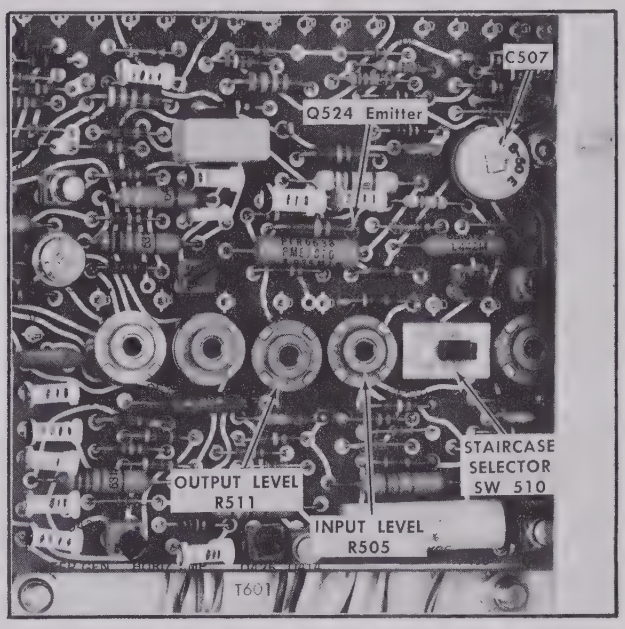



**Fig. 5-39. Location of OUTPUT LEVEL, R511, STAIRCASE SELECTOR, SW510, emitter of Q524, C507, and INPUT LEVEL, R505.**

h. Performance Check—Set STAIRCASE SELECTOR switch SW510, (see Fig. 5-39) to the other position and repeat part g.

i. Connect a 5 volt, 1 kHz peak to peak square wave signal from the square wave generator to pin C of the J501 plug.

j. Connect a 10× probe from the test oscilloscope vertical input connector to the emitter of Q524.

k. Set the test oscilloscope for a vertical deflection of 0.5 v/division, DC coupled, at a sweep rate of 0.1 ms/division with internal triggering.

l. Adjust square wave generator output signal so it is exactly 5 volts in amplitude.

m. Calibration Check—Check that top of square wave as displayed on test oscilloscope is flat.

n. Calibration Adjust—Adjust C507 (see Fig. 5-39) until top of square wave as displayed on test oscilloscope is flat.

o. Disconnect square wave generator.

p. Disconnect 10× probe from the emitter of Q554 and connect it to pin C of J501 plug.

q. Connect a 3-step (RGB) staircase signal to pin C of J501 plug along with the 10× probe.

r. Set the test oscilloscope for vertical deflection of 0.2 v/division, DC coupled, at a sweep rate of 5 ms/division with internal triggering.

s. Set the STAIRCASE SELECTOR switch SW510 (see Fig. 5-39) to its 3-step (RGB) position.

t. Performance Check—Check test oscilloscope display for a flat level for each of the steps and the Type RM529 MOD 188D for equal separation between the sweeps.

u. Calibration Adjust—Adjust INPUT LEVEL control R505 (see Fig. 5-39) for a flat level for each step as displayed on the test oscilloscope and for equal seperation between the sweeps.

v. Disconnect the 3-step (RGB) staircase signal from pin C of J501 and connect a 4-step (4 YRGB) staircase signal in its place.

w. Set the STAIRCASE SELECTOR SW510 (see Fig. 5-39) to its 4-step (YRGB) position.

x. Calibration Check—Check test oscilloscope display for a flat level for each of the steps and the Type RM529 MOD 188D for equal separation between the sweeps.

y. Calibration Adjust—Adjust INPUT LEVEL control R505 (see Fig. 5-39) for a flat level for each step as displayed on the test oscilloscope and for equal separation between the sweeps.

z. Disconnect the 9-pin plug from J501, the 4-step staircase generator, the test oscilloscope and the 10× probe, 75 ohm termination and composite video signal source.

### 42. Adjust Sin² Pulse and Bar Response (C167) ◑

a. Test equipment setup is given in step 41.

b. Connect a 1 volt sin² pulse and bar video signal to the upper VIDEO INPUTS A connector.

c. Connect a 75 ohm termination to the lower VIDEO INPUTS A connector.

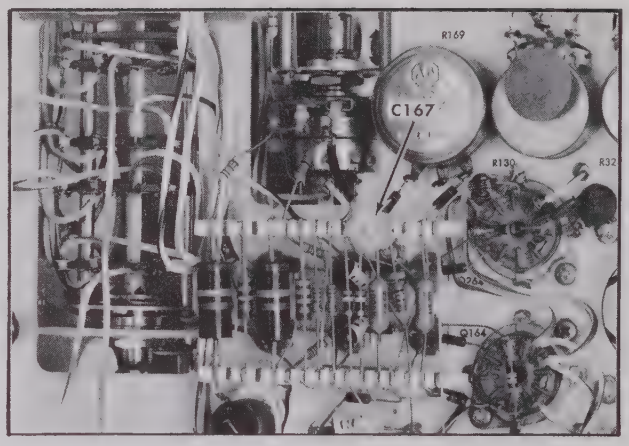



**Fig. 5-40. Location of C167.**

d. Reset the following controls:

| | |
|---|---|
| VOLTS FULL SCALE | Adjusted for 100 IRE units of sin² pulse and bar signal. |
| VARIABLE (VOLTS FULL SCALE) | |
| DISPLAY | 1 LINE |

e. Performance Check—Check top of bar portion of sin² pulse and bar signal for optimum flatness.

f. Calibration Adjust—Adjust C167 (see Fig. 5-40) for optimum flat top on bar portion of sin² pulse and bar signal.

g. Disconnect sin² pulse and bar signal source and 75 ohm termination.

## NOTES

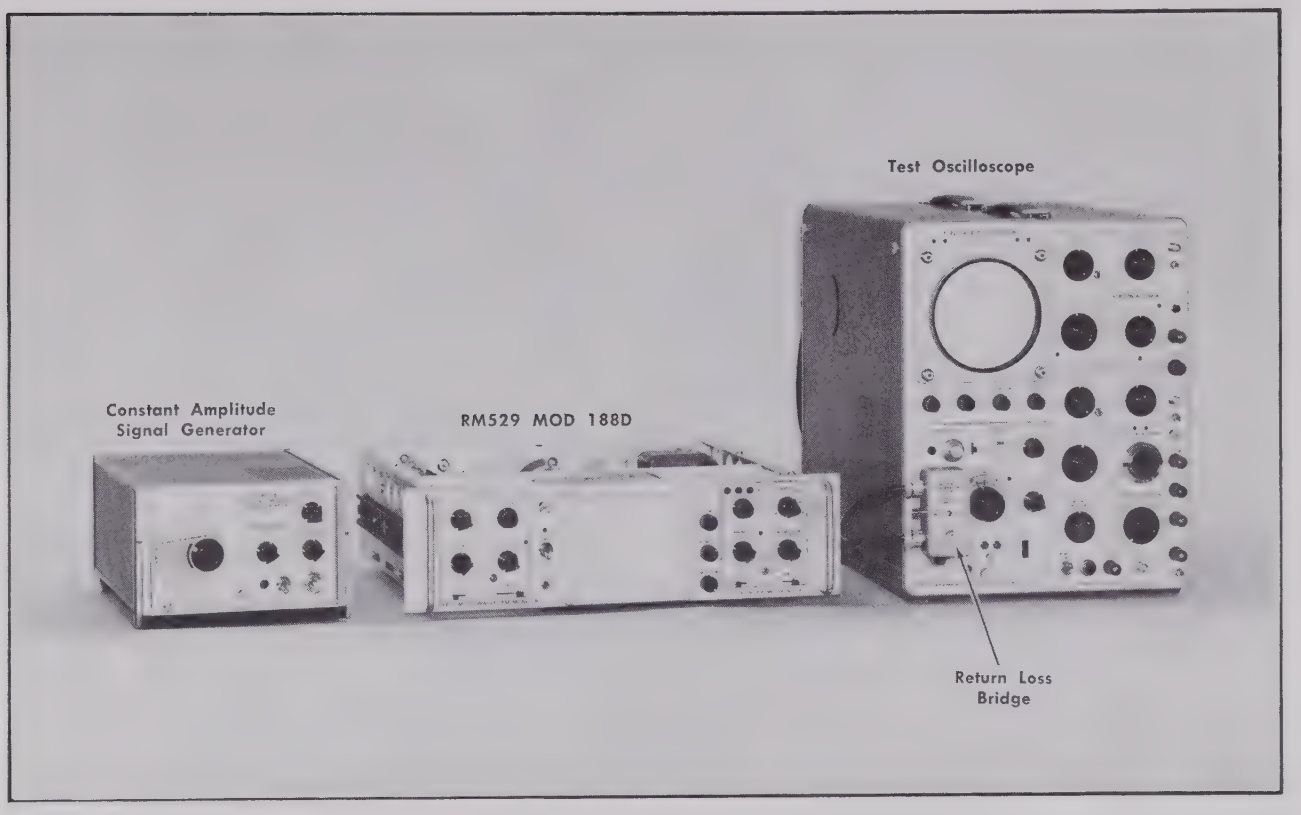



Fig. 5-41. Test equipment required for step 42.

Control settings:

| | |
|---|---|
| POWER | On |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjust for normal display brightness |
| GAIN | As is |
| VERTICAL Controls | |
| RESPONSE | FLAT |
| DC RESTORER | ON |
| INPUT | A-AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CAL | .714 F. S. |
| POSITION | Midrange |
| HORIZONTAL Controls | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | ×1 |
| MAGNIFIER VARIABLE | CALIB |
| DISPLAY | 2 LINE |
| FIELD | ONE |
| VARIABLE (LINE SELECTOR) | Midrange |
| LINE SELECTOR switch | VARIABLE |
| LINE & FIELD RATE | 525/60 |
| PAL FRAME SELECTOR | NORM |

### 43. Adjust Instrument Return Loss (L101 and L201)

a. Test equipment setup is shown in Fig. 5-41.

b. Connect the 067-0576-00 calibration fixture to the vertical input connectors of the test oscilloscope.

c. Connect a 5 MHz sine wave signal from a constant amplitude sine wave generator via a 50 ohm coaxial cable and a 50 ohm to 75 ohm minimum loss attenuator to the signal input connector on the 067-0576-00 calibration fixture.

d. Connect the matched 75 ohm terminations to the end of each coaxial cable of the 067-0576-00 calibration fixture.

e. Set the test oscilloscope for a vertical deflection of 0.2 V/division both input channels set for A-B operation with a free running sweep.

f. Remove one matched 75 ohm termination and check the constant amplitude sine wave generator for a 0.5 V, 5 MHz output sine wave signal as observed on the test oscilloscope, then replace the matched 75 ohm termination.

g. Set the test oscilloscope for a vertical deflection of 1 mV/division, both input channels AC coupled, and set for A-B operation at a sweep rate of 20 $\mu$s/division with a free-running sweep.

h. Check test oscilloscope display for an amplitude of 1 mV or less.

i. Disconnect a 75 ohm termination from the end of the measuring cable then attach the measuring cable to the Type RM529 MOD 188D upper VIDEO INPUTS A connector and the 75 ohm termination just removed, to the lower VIDEO INPUTS A connector.

j. Rotate the Type RM529 MOD 188D INPUT switch through all of its switch positions.

k. Check test oscilloscope display for an amplitude of not more than 2.5 mV minus the signal amplitude noted in part h of this step.

l. Adjust L101 (feed-through coil) by compressing the turns together or expanding them apart until the test oscilloscope display amplitude in all INPUT switch positions stays at or below 2.5 mV minus the signal amplitude noted in part h of this step.

m. Disconnect the measuring cable from the Type RM529 MOD 188D upper VIDEO INPUTS A connector and connect it to the upper VIDEO INPUTS B connector. Disconnect the 75 ohm termination from the lower VIDEO INPUTS A connector and connect it to the lower VIDEO INPUTS B connector.

n. Rotate the Type RM529 MOD 188D INPUT switch through all of its positions.

o. Check test oscilloscope display for an amplitude of not more than 2.5 mV minus the signal amplitude noted in part h of this step.

p. Adjust L201 (feed-through coil) by compressing the turns together or expanding them apart until the test oscilloscope display amplitude in all INPUT switch positions stays at or below 2.5 mV minus the signal amplitude noted in part h of this step.

q. Disconnect the 067-0576-00 calibration fixture (this includes the 75 ohm termination still attached to the Type RM529 MOD 188D), constant amplitude sine wave generator, test oscilloscope, 50 ohm coaxial cable and 50 ohm to 75 ohm minimum loss attenuator.

## NOTES

# PARTS LIST ABBREVIATIONS

| | |
|---|---|
| BHB | binding head brass |
| BHS | binding head steel |
| cap. | capacitor |
| cer | ceramic |
| comp | composition |
| conn | connector |
| CRT | cathode-ray tube |
| csk | countersunk |
| DE | double end |
| dia | diameter |
| div | division |
| elect. | electrolytic |
| EMC | electrolytic, metal cased |
| EMT | electrolytic, metal tubular |
| ext | external |
| F & I | focus and intensity |
| FHB | flat head brass |
| FHS | flat head steel |
| Fil HB | fillister head brass |
| Fil HS | fillister head steel |
| h | height or high |
| hex. | hexagonal |
| HHB | hex head brass |
| HHS | hex head steel |
| HSB | hex socket brass |
| HSS | hex socket steel |
| ID | inside diameter |
| inc | incandescent |
| int | internal |
| lg | length or long |
| met. | metal |
| mtg hdw | mounting hardware |
| OD | outside diameter |
| OHB | oval head brass |
| OHS | oval head steel |
| P/O | part of |
| PHB | pan head brass |
| PHS | pan head steel |
| plstc | plastic |
| PMC | paper, metal cased |
| poly | polystyrene |
| prec | precision |
| PT | paper, tubular |
| PTM | paper or plastic, tubular, molded |
| RHB | round head brass |
| RHS | round head steel |
| SE | single end |
| SN or S/N | serial number |
| S or SW | switch |
| TC | temperature compensated |
| THB | truss head brass |
| thk | thick |
| THS | truss head steel |
| tub. | tubular |
| var | variable |
| w | wide or width |
| WW | wire-wound |

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

## SPECIAL NOTES AND SYMBOLS

| | |
|---|---|
| ×000 | Part first added at this serial number |
| 00× | Part removed after this serial number |
| *000-0000-00 | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components. |
| Use 000-0000-00 | Part number indicated is direct replacement. |

# SECTION 6
# ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Bulbs** | | | |
| B242 | 150-0030-00 | | | Neon, NE 2 V | | | |
| B480A | 150-0034-00 | | | 28 V, red lens | | | |
| B480B | 150-0033-00 | | | 28 V, green lens | | | |
| B480C | 150-0091-00 | | | Incandescent, 28 V, 40 mA | | | |
| B480D | 150-0032-00 | | | 28 V, amber lens | | | |
| B559 | 150-0030-00 | | | Neon, NE 2 V | | | |
| B604 | 150-0001-00 | | | Incandescent, #47, 150 mA | | | |
| B605 | 150-0001-00 | | | Incandescent, #47, 150 mA | | | |
| B866 | 150-0030-00 | | | Neon, NE 2 V | | | |
| | | | | **Capacitors** | | | |
| Tolerance ±20% unless otherwise indicated. | | | | | | | |
| C101 | 281-0509-00 | | | 15 pF | Cer | 500 V | 10% |
| C104 | 285-0623-00 | | | 0.47 μF | PTM | 100 V | |
| C106 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C113 | 281-0604-00 | | | 2.2 pF | Selected (nominal value) | | |
| C118B | 281-0061-00 | | | 5.5-18 pF, Var | Cer | | |
| C118C | 281-0063-00 | | | 9-35 pF, Var | Cer | | |
| C118D | 281-0509-00 | | | 15 pF | Cer | 500 V | 10% |
| C119 | 281-0060-00 | | | 2-8 pF, Var | Cer | | |
| C122 | 283-0004-00 | | | 0.02 μF | Cer | 150 V | |
| C124 | 283-0003-00 | | | 0.01 μF | Cer | 150 V | |
| C130 | 283-0006-00 | | | 0.02 μF | Cer | 500 V | |
| C131 | 285-0622-00 | | | 0.1 μF | PTM | 100 V | |
| C132B | 281-0594-00 | 9500 | 10069 | 150 pF | Cer | 100 V | 5% |
| C132B | 283-0638-00 | 10070 | | 130 pF | Mica | 100 V | 1% |
| C133 | 283-0533-00 | | | 39 pF | Mica | 500 V | 5% |
| C134 | 283-0652-00 | | | 150 pF | Mica | 100 V | 1% |
| C135 | 283-0620-00 | | | 470 pF | Mica | 300 V | 1% |
| C136 | 283-0602-00 | | | 53 pF | Mica | 300 V | 5% |
| C137 | 281-0594-00 | 9500 | 13399 | 150 pF | Cer | 100 V | 5% |
| C137 | 283-0644-00 | 13400 | | 150 pF | Mica | 500 V | 1% |
| C138 | 283-0635-00 | | | 51 pF | Mica | 100 V | 1% |
| C139 | 283-0599-00 | | | 98 pF | Mica | 500 V | 5% |
| C140A | 283-0602-00 | 9500 | 10069 | 53 pF | Mica | 300 V | 5% |
| C140A | 283-0600-00 | 10070 | | 43 pF | Mica | 500 V | 5% |
| C140B | 281-0092-00 | | | 9-35 pF, Var | Cer | | |
| C140C | 281-0091-00 | 9500 | 10069X | 2-8 pF, Var | Cer | | |
| C140D | 281-0617-00 | | | 15 pF | Cer | 200 V | |
| C140F | 281-0601-00 | | | 7.5 pF | Cer | 500 V | ±0.5 pF |

## Capacitors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| C140G | 281-0093-00 | | | 5.5-18 pF, Var | Cer | | |
| C140H | 281-0091-00 | | | 2-8 pF, Var | Cer | | |
| C144 | 281-0558-00 | | | 18 pF | Cer | 500 V | |
| C150 | 283-0000-00 | X10690 | | 0.001 μF | Cer | 500 V | |
| C160 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C163 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C167 | 281-0063-00 | | | 9-35 pF, Var | Cer | | |
| C170 | 281-0512-00 | X10690 | | 27 pF | Cer | 500 V | 10% |
| C198 | 290-0217-00 | | | 250 μF | Elect. | 12 V | |
| C201 | 281-0509-00 | | | 15 pF | Cer | 500 V | 10% |
| C204 | 285-0623-00 | | | 0.47 μF | PTM | 100 V | |
| C206 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C213 | 281-0604-00 | | | 2.2 pF | Selected (nominal value) | | |
| C232 | 281-0097-00 | | | 9-35 pF, Var | Cer | | |
| C232B | 281-0594-00 | 9500 | 10069 | 150 pF | Cer | 100 V | 5% |
| C232B | 283-0638-00 | 10070 | | 130 pF | Mica | 100 V | 1% |
| C233 | 283-0552-00 | | | 200 pF | Mica | 500 V | 1% |
| C234 | 283-0654-00 | | | 790 pF | Mica | 100 V | 1% |
| C235 | 283-0620-00 | | | 470 pF | Mica | 300 V | 1% |
| C236 | 283-0602-00 | | | 53 pF | Mica | 300 V | 5% |
| C238 | 283-0635-00 | | | 51 pF | Mica | 100 V | 1% |
| C239 | 281-0092-00 | | | 9-35 pF, Var | Cer | | |
| C240D | 281-0617-00 | | | 15 pF | Cer | 200 V | |
| C244 | 281-0558-00 | | | 18 pF | Cer | 500 V | |
| C263 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C267 | 281-0512-00 | | | 27 pF | Cer | 500 V | 10% |
| C269 | 281-0012-00 | | | 7-45 pF, Var | Cer | | |
| C274 | 281-0578-00 | 9500 | 11429X | 18 pF | Cer | 500 V | 5% |
| C275 | 283-0113-00 | 9500 | 11429 | 56 pF | Cer | 500 V | 1% |
| C275 | 283-0647-00 | 11430 | | 70 pF | Mica | 100 V | 1% |
| C281 | 283-0026-00 | | | 0.2 μF | Cer | 25 V | |
| C285 | 281-0549-00 | | | 68 pF | Cer | 500 V | 10% |
| C286 | 281-0549-00 | | | 68 pF | Cer | 500 V | 10% |
| C292 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C293 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C294 | 281-0523-00 | | | 100 pF | Cer | 350 V | |
| C297 | 283-0067-00 | | | 0.001 μF | Cer | 200 V | 10% |
| C301 | 285-0622-00 | | | 0.1 μF | PTM | 100 V | |
| C302 | 281-0543-00 | | | 270 pF | Cer | 500 V | 10% |
| C303 | 283-0041-00 | | | 0.0033 μF | Cer | 500 V | 5% |
| C304 | 283-0596-00 | | | 528 pF | Mica | 300 V | 1% |
| C305 | 283-0602-00 | | | 53 pF | Mica | 300 V | 5% |
| C317 | 283-0059-00 | | | 1 μF | Cer | 25 V | +80%—20% |
| C327 | 281-0516-00 | | | 39 pF | Cer | 500 V | 10% |
| C335 | 281-0546-00 | | | 330 pF | Cer | 500 V | 10% |
| C341 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C342 | 283-0059-00 | | | 1 μF | Cer | 25 V | +80%—20% |

## Capacitors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| C347 | 281-0523-00 | | | 100 pF | Cer | 350 V | |
| C351 | 281-0513-00 | | | 27 pF | Cer | 500 V | |
| C360 | 283-0593-01 | | | 0.01 μF | Mica | 100 V | 1% |
| C361 | 281-0534-00 | | | 3.3 pF | Cer | 500 V | ±0.25 pF |
| C364 | 283-0596-00 | | | 528 pF | Mica | 300 V | 1% |
| C370 | 281-0546-00 | | | 330 pF | Cer | 500 V | 10% |
| C371 | 283-0081-00 | 9500 | 14289 | 0.1 μF | Cer | 25 V | +80%—20% |
| C371 | 283-0024-00 | 14290 | | 0.1 μF | Cer | 30 V | +80%—20% |
| C372 | 281-0550-00 | | | 120 pF | Cer | 500 V | 10% |
| C374 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C375 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C377 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C380 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C381 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C384 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C385 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C387 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C401 | 281-0510-00 | | | 22 pF | Cer | 500 V | |
| C402 | 281-0546-00 | | | 330 pF | Cer | 500 V | 10% |
| C409 | 281-0519-00 | | | 47 pF | Cer | 500 V | 10% |
| C412 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C415 | 283-0003-00 | | | 0.01 μF | Selected (nominal value) | | |
| C416 | 285-0633-00 | | | 0.22 μF | PTM | 100 V | 10% |
| C418 | 283-0110-00 | | | 0.005 μF | Cer | 150 V | |
| C427 | 281-0525-00 | | | 470 pF | Cer | 500 V | |
| C428 | 281-0621-00 | | | 12 pF | Cer | 500 V | 1% |
| C431 | 281-0525-00 | | | 470 pF | Cer | 500 V | |
| C439 | 283-0010-00 | | | 0.05 μF | Cer | 50 V | |
| C441 | 281-0524-00 | | | 150 pF | Cer | 500 V | |
| C449 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C452 | 281-0543-00 | | | 270 pF | Cer | 500 V | 10% |
| C455 | 281-0523-00 | | | 100 pF | Cer | 350 V | |
| C462 | 281-0528-00 | | | 82 pF | Cer | 500 V | 10% |
| C463 | 285-0595-00 | | | 0.1 μF | PTM | 100 V | 1% |
| C464 | 281-0551-00 | 9500 | 14999 | 390 pF | Cer | 500 V | 10% |
| C464 | 283-0032-00 | 15000 | | 470 pF | Cer | 500 V | 5% |
| C465 | 281-0519-00 | | | 47 pF | Cer | 500 V | 10% |
| C469 | 283-0026-00 | | | 0.2 μF | Cer | 25 V | |
| C470 | 281-0523-00 | | | 100 pF | Cer | 350 V | |
| C473 | 283-0004-00 | | | 0.02 μF | Cer | 150 V | |
| C477 | 283-0096-01 | 9500 | 11569 | 500 pF | Cer | 20,000 V | |
| C477 | 283-0096-00 | 11570 | | 500 pF | Cer | 20,000 V | |
| C478 | 283-0079-00 | | | 0.01 μF | Cer | 250 V | |
| C479 | 281-0509-00 | X13100 | | 15 pF | Cer | 500 V | 10% |
| C480 | 285-0683-00 | | | 0.022 μF | PTM | 100 V | 5% |
| C481 | 281-0022-00 | | | 8-50 pF, Var | Cer | | |
| C481A | 281-0022-00 | | | 8-50 pF, Var | Cer | | |
| C481B | 281-0022-00 | | | 8-50 pF, Var | Cer | | |
| C481C | 281-0022-00 | | | 8-50 pF, Var | Cer | | |

## Capacitors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| C481D | 281-0022-00 | | | 8-50 pF, Var | Cer | | |
| C481E | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C481F | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C482 | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C482A | 283-0604-00 | | | 304 pF | Mica | 300 V | 2% |
| C482B | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C482C | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C482D | 283-0630-00 | | | 110 pF | Mica | 100 V | 1% |
| C482E | 283-0604-00 | | | 304 pF | Mica | 300 V | 2% |
| C482F | 283-0644-00 | | | 150 pF | Mica | 500 V | 1% |
| C483 | 285-0595-00 | | | 0.1 μF | PTM | 100 V | 1% |
| C484 | 283-0001-00 | | | 0.005 μF | Cer | 500 V | |
| C485 | 283-0641-00 | | | 180 pF | Mica | 100 V | 1% |
| C486 | 285-0598-00 | | | 0.01 μF | Selected (nominal value) | | |
| C487 | 281-0525-00 | | | 470 pF | Cer | 500 V | |
| C507 | 281-0022-00 | | | 8-50 pF, Var | Cer | | |
| C512 | 281-0632-00 | | | 35 pF | Cer | 500 V | 1% |
| C516 | 281-0513-00 | | | 27 pF | Cer | 500 V | |
| C518 | 281-0645-00 | | | 8.2 pF | Cer | 500 V | ±0.25 pF |
| C520 | 281-0557-00 | | | 1.8 pF | Cer | 500 V | 10% |
| C521 | 281-0546-00 | | | 330 pF | Cer | 500 V | 10% |
| C522 | 281-0518-00 | | | 47 pF | Cer | 500 V | |
| C523 | 281-0031-00 | | | 3-12 pF, Var | Cer | | |
| C526 | 281-0510-00 | | | 22 pF | Cer | 500 V | |
| C527 | 281-0031-00 | | | 3-12 pF, Var | Cer | | |
| C552 | 283-0119-00 | 9500 | 12279 | 2200 pF | Cer | 200 V | 5% |
| C552 | 283-0077-00 | 12280 | | 330 pF | Cer | 500 V | 5% |
| C553 | 283-0003-00 | | | 0.01 μF | Cer | 150 V | |
| C568 | 285-0627-00 | | | 0.0033 μF | PTM | 100 V | 5% |
| C575 | 283-0059-00 | | | 1 μF | Cer | 25 V | +80%—20% |
| C578 | 290-0145-00 | | | 10 μF | Elect. | 50 V | |
| C579 | 283-0079-00 | | | 0.01 μF | Cer | 250 V | |
| C610 | 290-0122-00 | | | 1000 μF | Elect. | 50 V | |
| C617 | 283-0002-00 | | | 0.01 μF | Cer | 500 V | |
| C620 | 290-0145-00 | | | 10 μF | Elect. | 50 V | |
| C626 | 283-0003-00 | | | 0.01 μF | Cer | 150 V | |
| C640 | 290-0130-00 | | | 2 x 125 μF | Elect. | 350 V | |
| C644 | 283-0079-00 | | | 0.01 μF | Cer | 250 V | |
| C646 | 283-0057-00 | | | 0.1 μF | Cer | 200 V | +80%—20% |
| C649 | 290-0149-00 | | | 5 μF | Elect. | 150 V | |
| C650 | 290-0017-00 | | | 125 μF | Elect. | 450 V | |
| C651 | 290-0213-00 | | | 10 μF | Elect. | 450 V | |
| C654 | 283-0002-00 | | | 0.01 μF | Cer | 500 V | |
| C800 | 290-0213-00 | | | 10 μF | Elect. | 450 V | |
| C804 | 290-0267-00 | | | 1 μF | Elect. | 35 V | |
| C805 | 283-0013-00 | | | 0.01 μF | Cer | 1000 V | |

## Capacitors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| C806 | 283-0002-00 | | | 0.01 μF | Cer | 500 V | |
| C814 | 290-0255-00 | | | 20 μF | Elect. | 50 V | |
| C816 | 283-0092-00 | | | 0.03 μF | Cer | 200 V | +80%—20% |
| C818 | 283-0059-00 | | | 1 μF | Cer | 25 V | +80%—20% |
| C819 | 281-0562-00 | | | 39 pF | Cer | 500 V | |
| C821 | 283-0004-00 | | | 0.02 μF | Cer | 150 V | |
| C822 | 283-0036-00 | | | 2500 pF | Cer | 60,000 V | |
| C832 | 281-0556-00 | | | 500 pF | Cer | 10,000 V | |
| C833 | 283-0013-00 | X14648 | | 0.01 μF | Cer | 1000 V | |
| C836 | 283-0082-00 | | | 0.01 μF | Cer | 4000 V | +80%—20% |
| C846 | 283-0082-00 | | | 0.01 μF | Cer | 4000 V | +80%—20% |
| C847 | 283-0002-00 | | | 0.01 μF | Cer | 500 V | |
| C850 | 283-0087-00 | | | 300 pF | Cer | 1000 V | 10% |
| C865 | 283-0002-00 | | | 0.01 μF | Cer | 500 V | |
| C875 | 281-0513-00 | | | 27 pF | Cer | 500 V | |
| C876 | 283-0032-00 | | | 470 pF | Cer | 500 V | 5% |
| C1347 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C1375 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C1377 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |
| C1385 | 281-0536-00 | | | 1000 pF | Cer | 500 V | 10% |
| C1387 | 283-0000-00 | | | 0.001 μF | Cer | 500 V | |

## Semiconductor Device, Diodes

| | | | | |
|---|---|---|---|---|
| D110 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D124 | 152-0168-00 | X10836 | Zener | 1N963B 400 mW, 12 V, 5% |
| D161 | *152-0061-00 | | Silicon | Tek Spec |
| D210 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D271 | *152-0075-00 | | Germanium | Tek Spec |
| D272 | *152-0075-00 | | Germanium | Tek Spec |
| D282 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D285 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D286 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D292 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D293 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D301 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D304 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D314 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D315 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D317 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D318 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D323 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D333 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D341 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D346 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D351 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D362 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D363 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D368 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |
| D370 | *152-0185-00 | | Silicon | Replaceable by 1N4152 |

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## Semiconductor Device, Diodes *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description |
|---|---|---|---|---|
| D371 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D374 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D375 | *152-0107-00 | | | Silicon Replaceable by 1N647 |
| D377 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D384 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D385 | *152-0107-00 | | | Silicon Replaceable by 1N647 |
| D387 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D413 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D414 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D415 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D423 | *152-0075-00 | | | Germanium Tek Spec |
| D425 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D434 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D441 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D444 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D452 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D455 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D456 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D461 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D462 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D463 | *152-0075-00 | | | Germanium Tek Spec |
| D464 | *152-0061-00 | | | Silicon Tek Spec |
| D466 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D469 | 152-0278-00 | | | Zener 1N4372A 400 mW, 3 V, 5% |
| D470 | 152-0282-00 | | | Zener 1N972B 400 mW, 30 V, 5% |
| D471 | *152-0061-00 | | | Silicon Tek Spec |
| D472 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D473 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D474 | *152-0061-00 | | | Silicon Tek Spec |
| D475 | *152-0061-00 | | | Silicon Tek Spec |
| D481 | *152-0185-00 | 9500 | 11699 | Silicon Replaceable by 1N4152 |
| D481 | 152-0283-00 | 11700 | | Zener 1N976B, 400 mV, 43 V, 5% |
| D482 | *152-0249-00 | | | Silicon Assembly |
| D510 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D519 | 152-0168-00 | | | Zener 1N963A 400 mW, 12 V, 5% |
| D552 | *152-0185-00 | X10071 | 12279X | Silicon Replaceable by 1N4152 |
| D553 | 152-0278-00 | X10071 | 10403 | Zener 1N4372A 400 mV, 3 V, 5% |
| D553 | 152-0279-00 | 10404 | 12279X | Zener 1N751A 400 mW, 5.1 V, 5% |
| D554 | 152-0166-00 | | | Zener 1N753A 400 mW, 6.2 V, 5% |
| D555 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D556 | *152-0426-00 | X12280 | | Silicon Replaceable by 1N647 |
| D574 | 152-0022-00 | | | Zener 1M25Z5 1 W, 25 V, 5% |
| D575 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D610 | 152-0066-00 | | | Silicon 1N3194 |
| D611 | 152-0066-00 | | | Silicon 1N3194 |
| D614 | 152-0123-00 | | | Zener 1N935A 400 mW, 9.1 V, 5% TC |
| D621 | 152-0066-00 | X11700 | | Silicon 1N3194 |
| D640A,B,C,D (4) | 152-0066-00 | | | Silicon 1N3194 |
| D643 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D649 | 152-0066-00 | | | Silicon 1N3194 |
| D650A,B,C,D (4) | 152-0066-00 | | | Silicon 1N3194 |
| D653 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D803 | *152-0061-00 | | | Silicon Tek Spec |

## Semiconductor Device, Diodes *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description |
|---|---|---|---|---|
| D805 | 152-0170-00 | | | Silicon 1N4441 |
| D806 | 152-0170-00 | | | Silicon 1N4441 |
| D810 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D822 | 152-0218-00 | 9500 | 10099 | Silicon 10,000 V, 20 mA |
| D822 | 152-0408-00 | 10100 | | Silicon 10,000 V 5 mA |
| D832 | 152-0218-00 | 9500 | 10099 | Silicon 10,000 V, 20 mA |
| D832 | 152-0408-00 | 10100 | | Silicon 10,000 V 5 mA |
| D847 | 152-0298-00 | | | Zener 1.5 W, 140 V, 5% |
| D865 | 152-0287-00 | | | Zener 1N986B 400 mW, 110 V, 5% |
| D881 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1374 | 152-0141-02 | | | Silicon 1N4152 |
| D1375 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1376 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1377 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1384 | 152-0141-02 | | | Silicon 1N4152 |
| D1385 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1386 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |
| D1387 | *152-0185-00 | | | Silicon Replaceable by 1N4152 |

## Fuses

| | | | |
|---|---|---|---|
| F601 | 159-0023-00 | | 2A 3AG Slo-Blo |
| F637 | 159-0018-00 | | 4/5A 3AG Slo-Blo |
| F648 | 159-0030-00 | | 0.3A 3AG Fast-Blo |
| F658 | 159-0030-00 | | 0.3A 3AG Fast-Blo |

## Connectors

| | | | | |
|---|---|---|---|---|
| J101 | 131-0064-00 | 9500 | 10099 | Coaxial |
| J101 | 131-0279-00 | 10100 | 10697 | BNC |
| J101 | 131-0274-00 | 10698 | | BNC |
| J102 | 131-0064-00 | 9500 | 10099 | Coaxial |
| J102 | 131-0279-00 | 10100 | 10697 | BNC |
| J102 | 131-0274-00 | 10698 | | BNC |
| J198 | 131-0081-00 | 9500 | 10099 | UHF, 1 contact, female |
| J198 | 131-0126-00 | 10100 | | BNC, 1 contact |
| J201 | 131-0064-00 | 9500 | 10099 | Coaxial |
| J201 | 131-0279-00 | 10100 | 10697 | BNC |
| J201 | 131-0274-00 | 10698 | | BNC |
| J202 | 131-0064-00 | 9500 | 10099 | Coaxial |
| J202 | 131-0279-00 | 10100 | 10697 | BNC |
| J202 | 131-0274-00 | 10698 | | BNC |
| J301 | 131-0081-00 | 9500 | 10099 | UHF, 1 contact, female |
| J301 | 131-0126-00 | 10100 | | BNC, 1 contact |
| J302 | 131-0081-00 | 9500 | 10099 | UHF, 1 contact, female |
| J302 | 131-0126-00 | 10100 | | BNC, 1 contact |
| J501 | 136-0089-00 | | | 9 pin |
| J885 | 131-0081-00 | 9500 | 10099 | UHF, 1 contact, female |
| J885 | 131-0126-00 | 10100 | | BNC, 1 contact |
| J886 | 131-0081-00 | 9500 | 10099 | UHF, 1 contact, female |
| J886 | 131-0126-00 | 10100 | | BNC, 1 contact |

## Relay

| | | |
|---|---|---|
| K501 | 148-0043-00 | 1325 Ω, 24 V DC |

©

## Inductors

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description |
|---|---|---|---|---|
| L101 | *108-0326-00 | 9500 | 12599 | 150 nH |
| L101 | *108-0638-00 | 12600 | | 100 nH |
| L113 | 276-0507-00 | | | Core, ferramic suppressor |
| L131 | 276-0541-00 | X11430 | | Core, ferrite |
| L132 | *108-0237-00 | | | 80 μH |
| L133 | 114-0200-00 | | | 60-120 μH, Var Core not replaceable |
| L133B | *108-0360-00 | | | 46 μH |
| L134 | 114-0174-00 | | | 120-280 μH, Var Core not replaceable |
| L134B | *108-0459-00 | | | 36 μH |
| L135 | 114-0174-00 | | | 120-280 μH, Var Core not replaceable |
| L136 | *114-0253-00 | | | 280-470 μH, Var Core 276-0506-00 |
| L137 | *108-0458-00 | | | 72 μH |
| L138 | *114-0241-00 | | | 23-64 μH Var Core not replaceable |
| L139 | *108-0497-00 | | | 14 μH |
| L144 | 276-0507-00 | | | Core, ferramic suppressor |
| L159 | *108-0260-00 | | | 0.1 μH |
| L162 | *114-0182-00 | | | 58-90 μH, Var Core 276-0511-00 (2) |
| L201 | *108-0326-00 | 9500 | 12599 | 150 nH |
| L201 | *108-0638-00 | 12600 | | 100 nH |
| L213 | 276-0507-00 | | | Core, ferramic suppressor |
| L232 | *108-0237-00 | | | 80 μH |
| L233 | 114-0200-00 | | | 60-120 μH, Var Core not replaceable |
| L233B | *108-0360-00 | | | 46 μH |
| L234 | 114-0174-00 | | | 120-280 μH, Var Core not replaceable |
| L235 | 114-0174-00 | | | 120-280 μH, Var Core not replaceable |
| L236 | 276-0541-00 | X11430 | | Core, ferrite |
| L237 | *108-0458-00 | | | 72 μH |
| L238 | *114-0241-00 | | | 23-64 μH, Var Core not replaceable |
| L244 | 276-0507-00 | | | Core, ferramic suppressor |
| L259 | *108-0260-00 | | | 0.1 μH |
| L262 | *114-0182-00 | | | 58-90 μH, Var Core 276-0511-00 (2) |
| L274 | 108-0226-00 | 9500 | 11429X | 100 μH |
| L552 | 276-0507-00 | X12280 | | Core, ferramic suppressor |
| L655 | *108-0285-00 | | | CRT Beam Rotator |

## Transistors

| | | | | | |
|---|---|---|---|---|---|
| Q114 | *151-0108-00 | | | Silicon | Replaceable by 2N2501 |
| Q124 | *151-0154-00 | | | Silicon | Replaceable by 2N2924 |
| Q144 | *151-0133-00 | | | Silicon | Tek Spec |
| Q154 | *151-0108-00 | | | Silicon | Replaceable by 2N2501 |
| Q164 | *151-0127-00 | 9500 | 10689 | Silicon | Selected from 2N2369 |
| Q164[1] | *153-0526-00 | 10690 | 10835 | Silicon | Selected from 2N2369 (matched pair) |
| Q164 | *153-0528-00 | 10836 | | Silicon | Replaceable by 2N2219, checked |
| Q174 | 151-0063-00 | | | Germanium | 2N2207 |
| Q184 | 151-0063-00 | | | Germanium | 2N2207 |
| Q193 | 151-0080-00 | | | Silicon | 2N706 |
| Q214 | *151-0108-00 | | | Silicon | Replaceable by 2N2501 |
| Q244 | *151-0133-00 | | | Silicon | Tek Spec |
| Q254 | *151-0108-00 | | | Silicon | Replaceable by 2N2501 |
| Q264 | *151-0127-00 | 9500 | 10689 | Silicon | Selected from 2N2369 |
| Q264[1] | *153-0526-00 | 10690 | 10835 | Silicon | Selected from 2N2369 (matched pair) |
| C264 | *153-0528-00 | 10836 | | Silicon | Replaceable by 2N2219, checked |
| Q273 | *151-0153-00 | | | Silicon | Replaceable by 2N2923 |

[1]Furnished as a matched pair.

## Transistors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description |
|---|---|---|---|---|
| Q274 | 151-0063-00 | | | Germanium 2N2207 |
| Q280 | 151-0188-00 | | | Silicon 2N3906 |
| Q284 | 151-0063-00 | | | Germanium 2N2207 |
| Q314 | 151-0063-00 | | | Germanium 2N2207 |
| Q325 | *151-0133-00 | | | Silicon Tek Spec |
| Q335 | *151-0133-00 | | | Silicon Tek Spec |
| Q344 | *151-0133-00 | | | Silicon Tek Spec |
| Q355 | 151-0190-00 | | | Silicon 2N3904 |
| Q365 | 151-0190-00 | | | Silicon 2N3904 |
| Q375 | 151-0188-00 | | | Silicon 2N3906 |
| Q385 | 151-0188-00 | | | Silicon 2N3906 |
| Q414 | *151-0151-00 | 9500 | 15369 | Silicon Replaceable by 2N930 |
| Q414 | 151-0126-00 | 15370 | | Silicon 2N2484 |
| Q415 | *151-0151-00 | 9500 | 15369 | Silicon Replaceable by 2N930 |
| Q415 | 151-0126-00 | 15370 | | Silicon 2N2484 |
| Q425 | *151-0153-00 | | | Silicon Replaceable by 2N2923 |
| Q434 | 151-0188-00 | | | Silicon 2N3906 |
| Q465 | 151-0190-00 | | | Silicon 2N3904 |
| Q474 | *151-0124-00 | | | Silicon Selected from 2N3119 |
| Q481 | *151-0103-00 | 9500 | 11699 | Silicon Replaceable by 2N2219 |
| Q481 | 151-0190-00 | 11700 | | Silicon 2N3904 |
| Q483 | 151-1022-00 | | | Silicon FET |
| Q514 | 151-1005-00 | | | Silicon FET |
| Q524 | 151-0188-00 | | | Silicon 2N3906 |
| Q533 | 151-0221-00 | | | Silicon 2N4258 |
| Q544 | *151-0124-00 | | | Silicon Selected from 2N3119 |
| Q554 | *153-0571-00 | 9500 | 10070 | Silicon Selected from 40422 (RCA) |
| Q554 | *151-0286-00 | 10071 | 12279 | Silicon Tek Spec |
| Q554 | *151-0150-00 | 12280 | | Silicon Selected from 2N3440 |
| Q564 | *153-0571-00 | 9500 | 10070 | Silicon Selected from 40422 (RCA) |
| Q564 | *151-0286-00 | 10071 | | Silicon Tek Spec |
| Q574 | *151-0133-00 | | | Silicon Tek Spec |
| Q616 | *151-0151-00 | 9500 | 15369 | Silicon Replaceable by 2N930 |
| Q616 | 151-0126-00 | 15370 | | Silicon 2N2484 |
| Q626 | *151-0151-00 | 9500 | 15369 | Silicon Replaceable by 2N930 |
| Q626 | 151-0126-00 | 15370 | | Silicon 2N2484 |
| Q634 | *151-0153-00 | 9500 | 11699 | Silicon Replaceable by 2N2923 |
| Q634 | 151-0190-00 | 11700 | | Silicon 2N3904 |
| Q637 | 151-0137-00 | | | Germanium 2N2148 |
| Q643 | *151-0155-00 | | | Silicon Replaceable by 2N2925 |
| Q644 | *151-0134-00 | | | Silicon Replaceable by 2N2905 |
| Q647 | *151-0148-00 | | | Silicon Selected from 40250 (RCA) |
| Q653 | *151-0155-00 | | | Silicon Replaceable by 2N2925 |
| Q654 | 151-0214-00 | | | Silicon 2N3495 |
| Q657 | 151-0149-00 | | | Silicon 2N3441 |
| Q804 | *151-0136-00 | | | Silicon Selected from 2N3053 |
| Q874 | *151-0103-00 | | | Silicon Replaceable by 2N2219 |
| Q1375 | 151-0188-00 | | | Silicon 2N3906 |
| Q1385 | 151-0188-00 | | | Silicon 2N3906 |

## Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

| | | | | | |
|---|---|---|---|---|---|
| R101 | 315-0100-00 | 10 Ω | ¼ W | | 5% |
| R104 | 319-0031-00 | 1 MΩ | ¼ W | Prec | 1% |
| R106 | 316-0474-00 | 470 kΩ | ¼ W | | |
| R110 | 316-0101-00 | 100 Ω | ¼ W | | |
| R113 | 315-0682-00 | 6.8 kΩ | ¼ W | | 5% |

**Resistors** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R114 | 321-0227-00 | | | 2.26 kΩ | 1/8 W | Prec | 1% |
| R115 | 311-0546-00 | | | 10 kΩ, Var | | | |
| R118A | 321-0247-00 | | | 3.65 kΩ | 1/8 W | Prec | 1% |
| R118B | 321-0219-00 | | | 1.87 kΩ | 1/8 W | Prec | 1% |
| R118C | 321-0167-00 | | | 536 Ω | 1/8 W | Prec | 1% |
| R119 | 311-0169-00 | | | 100 Ω, Var | | | |
| R120 | 321-0175-00 | | | 649 Ω | 1/8 W | Prec | 1% |
| R121 | 308-0334-00 | | | 7 kΩ | 3 W | WW | 3% |
| R122 | 321-0173-00 | 9500 | 10689 | 619 Ω | 1/8 W | Prec | 1% |
| R122 | 321-0188-00 | 10690 | | 887 Ω | 1/8 W | Prec | 1% |
| R123 | 321-0250-00 | 9500 | 10835 | 3.92 kΩ | 1/8 W | Prec | 1% |
| R123 | 321-0250-00 | 10836 | | 3.92 kΩ | Selected | (nominal value) | |
| R124 | 315-0470-00 | X12600 | | 47 Ω | 1/4 W | | 5% |
| R125 | 321-0267-00 | 9500 | 10689 | 5.9 kΩ | 1/8 W | Prec | 1% |
| R125 | 321-0280-00 | 10690 | | 8.06 kΩ | 1/8 W | Prec | 1% |
| R130 | 311-0224-00 | | | 50 kΩ Var | | | |
| R131 | 315-0823-00 | | | 82 kΩ | 1/4 W | | 5% |
| R138 | 315-0470-00 | | | 47 Ω | 1/4 W | | 5% |
| R141 | 321-0121-00 | | | 178 Ω | 1/8 W | Prec | 1% |
| R143 | 305-0153-00 | 9500 | 10689 | 15 kΩ | 2 W | | 5% |
| R143 | 308-0391-00 | 10690 | | 7.2 kΩ | 3 W | WW | 5% |
| R144 | 321-0297-00 | | | 12.1 kΩ | 1/8 W | Prec | 1% |
| R148 | 301-0333-00 | | | 33 kΩ | 1/2 W | | 5% |
| R149 | 316-0392-00 | 9500 | 10689 | 3.9 kΩ | 1/4 W | | |
| R149 | 315-0822-00 | 10690 | | 8.2 kΩ | 1/4 W | | 5% |
| R150 | 321-0323-00 | X10690 | | 22.6 kΩ | 1/8 W | Prec | 1% |
| R154 | 321-0213-00 | | | 1.62 kΩ | 1/8 W | Prec | 1% |
| R155 | 321-0403-00 | X10690 | | 154 kΩ | 1/8 W | Prec | 1% |
| R160 | 308-0055-00 | 9500 | 10835 | 1.5 kΩ | 10 W | WW | 5% |
| R160 | 308-0017-00 | 10836 | | 2 kΩ | 10 W | WW | 5% |
| R161 | 308-0241-00 | | | 22 kΩ | 7 W | WW | 1% |
| R162 | *310-0621-00 | 9500 | 12599 | 3 kΩ | 8 W | Prec | 1% |
| R162 | *310-0621-01 | 12600 | | 3 kΩ | 8 W | Prec | 1% |
| R163 | 315-0104-00 | | | 100 kΩ | 1/4 W | | 5% |
| R164 | 316-0470-00 | 9500 | 10689 | 47 Ω | 1/4 W | | |
| R164 | 316-0101-00 | 10690 | | 100 Ω | 1/4 W | | |
| R165 | 316-0101-00 | | | 100 Ω | 1/4 W | | |
| R166 | 308-0077-00 | 9500 | 10835 | 1 kΩ | 3 W | WW | 5% |
| R166 | 308-0406-00 | 10836 | | 1.2 kΩ | 3 W | WW | 1% |
| R167 | 321-0335-00 | | | 30.1 kΩ | 1/8 W | Prec | 1% |
| R168 | 315-0750-00 | | | 75 Ω | 1/4 W | | 5% |
| R169 | 311-0003-00 | | | 100 Ω, Var | | | |
| R172 | 315-0112-00 | | | 1.1 kΩ | 1/4 W | | 5% |
| R173 | 304-0273-00 | | | 27 kΩ | 1 W | | |
| R183 | 316-0271-00 | | | 270 Ω | 1/4 W | | |
| R184 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R192 | 315-0242-00 | | | 2.4 kΩ | 1/4 W | | 5% |
| R193 | 304-0122-00 | | | 1.2 kΩ | 1 W | | |
| R197 | 316-0102-00 | | | 1 kΩ | 1/4 W | | |
| R198 | 301-0750-00 | | | 75 Ω | 1/2 W | | 5% |
| R199 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R201 | 315-0100-00 | | | 10 Ω | 1/4 W | | 5% |
| R204 | 319-0031-00 | | | 1 MΩ | 1/4 W | Prec | 1% |
| R206 | 316-0474-00 | | | 470 kΩ | 1/4 W | | |
| R210 | 316-0101-00 | | | 100 Ω | 1/4 W | | |

**Resistors** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R213 | 315-0682-00 | | | 6.8 kΩ | 1/4 W | | 5% |
| R214 | 321-0227-00 | | | 2.26 kΩ | 1/8 W | Prec | 1% |
| R220 | 321-0175-00 | | | 649 Ω | 1/8 W | Prec | 1% |
| R224 | 315-0470-00 | X12600 | | 47 Ω | 1/4 W | | 5% |
| R231 | 315-0823-00 | | | 82 kΩ | 1/4 W | | 5% |
| R238 | 315-0470-00 | | | 47 Ω | 1/4 W | | 5% |
| R240[2] | 311-0506-00 | 9500 | 12599 | 500 Ω, Var | | | |
| R240[2] | 311-0506-01 | 12600 | 12979 | 500 Ω, Var | | | |
| R240[2] | 311-1219-00 | 12980 | | 500 Ω, Var | | | |
| R241 | 321-0131-00 | | | 226 Ω | 1/8 W | Prec | 1% |
| R242 | 316-0224-00 | | | 220 kΩ | 1/4 W | | |
| R243 | 305-0153-00 | 9500 | 10689 | 15 kΩ | 2 W | | 5% |
| R243 | 308-0391-00 | 10690 | | 7.2 kΩ | 3 W | WW | 5% |
| R244 | 321-0297-00 | | | 12.1 kΩ | 1/8 W | Prec | 1% |
| R245 | 311-0016-00 | 9500 | 10689 | 10 kΩ, Var | | | |
| R245 | 311-0011-00 | 10690 | | 5 kΩ, Var | | | |
| R248 | 301-0333-00 | | | 33 kΩ | 1/2 W | | 5% |
| R249 | 316-0392-00 | 9500 | 10689 | 3.9 kΩ | 1/4 W | | |
| R249 | 315-0822-00 | 10690 | | 8.2 kΩ | 1/4 W | | 5% |
| R254 | 321-0213-00 | | | 1.62 kΩ | 1/8 W | Prec | 1% |
| R260 | 316-0271-00 | X10690 | | 270 Ω | 1/4 W | | |
| R262 | *310-0621-00 | 9500 | 12599 | 3 kΩ | 8 W | Prec | 1% |
| R262 | *310-0621-01 | 12600 | | 3 kΩ | 8 W | Prec | 1% |
| R263 | 315-0104-00 | | | 100 kΩ | 1/4 W | | 5% |
| R264 | 316-0470-00 | 9500 | 10689 | 47 Ω | 1/4 W | | |
| R264 | 316-0101-00 | 10690 | | 100 Ω | 1/4 W | | |
| R265 | 316-0101-00 | | | 100 Ω | 1/4 W | | |
| R266 | 308-0077-00 | 9500 | 10835 | 1 kΩ | 3 W | WW | 5% |
| R266 | 308-0406-00 | 10836 | | 1.2 kΩ | 3 W | WW | 1% |
| R267 | 316-0271-00 | | | 270 Ω | 1/4 W | | |
| R268 | 315-0750-00 | | | 75 Ω | 1/4 W | | 5% |
| R274 | 315-0153-00 | | | 15 kΩ | 1/4 W | | 5% |
| R275 | 315-0752-00 | | | 7.5 kΩ | 1/4 W | | 5% |
| R276 | 316-0104-00 | | | 100 kΩ | 1/4 W | | |
| R280 | 321-0300-00 | | | 13 kΩ | 1/8 W | Prec | 1% |
| R281 | 321-0273-00 | | | 6.81 kΩ | 1/8 W | Prec | 1% |
| R282 | 316-0105-00 | | | 1 MΩ | 1/4 W | | |
| R284 | 315-0150-00 | | | 15 Ω | 1/4 W | | 5% |
| R285 | 321-0385-00 | | | 100 kΩ | 1/8 W | Prec | 1% |
| R286 | 321-0385-00 | | | 100 kΩ | 1/8 W | Prec | 1% |
| R287 | 321-0328-00 | | | 25.5 kΩ | 1/8 W | Prec | 1% |
| R288 | 321-0328-00 | | | 25.5 kΩ | 1/8 W | Prec | 1% |
| R289 | 316-0333-00 | | | 33 kΩ | 1/4 W | | |
| R290 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | | 5% |
| R291 | 315-0153-00 | | | 15 kΩ | 1/4 W | | 5% |
| R292 | 315-0224-00 | | | 220 kΩ | 1/4 W | | 5% |
| R293 | 315-0224-00 | | | 220 kΩ | 1/4 W | | 5% |
| R296 | 316-0101-00 | | | 100 Ω | 1/4 W | | |
| R297 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R298 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | | 5% |
| R299 | 316-0104-00 | | | 100 kΩ | 1/4 W | | |
| R301 | 301-0564-00 | | | 560 kΩ | 1/2 W | | 5% |

[2]Furnished as a unit with SW240.

## Resistors (cont)

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R302 | 315-0392-00 | | | 3.9 kΩ | 1/4 W | | 5% |
| R303 | 315-0223-00 | | | 22 kΩ | 1/4 W | | 5% |
| R304 | 315-0155-00 | | | 1.5 MΩ | 1/4 W | | 5% |
| R305 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R310 | 316-0101-00 | | | 100 Ω | 1/4 W | | |
| R312 | 316-0104-00 | | | 100 kΩ | 1/4 W | | |
| R313 | 316-0153-00 | | | 15 kΩ | 1/4 W | | |
| R314 | 316-0682-00 | | | 6.8 kΩ | 1/4 W | | |
| R315 | 315-0333-00 | | | 33 kΩ | 1/4 W | | 5% |
| R317 | 302-0156-00 | | | 15 MΩ | 1/2 W | | |
| R318 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R319 | 316-0335-00 | | | 3.3 MΩ | 1/4 W | | |
| R323 | 323-0346-00 | | | 39.2 kΩ | 1/2 W | Prec | 1% |
| R324 | 321-0218-00 | | | 1.82 kΩ | 1/8 W | Prec | 1% |
| R325 | 311-0369-00 | | | 100 kΩ, Var | | | |
| R326 | 323-0414-00 | | | 200 kΩ | 1/2 W | Prec | 1% |
| R327 | 321-0297-00 | | | 12.1 kΩ | 1/8 W | Prec | 1% |
| R328 | 321-0387-00 | | | 105 kΩ | 1/8 W | Prec | 1% |
| R329 | 315-0333-00 | | | 33 kΩ | 1/4 W | | 5% |
| R333 | 323-0346-00 | | | 39.2 kΩ | 1/2 W | Prec | 1% |
| R334 | 302-0182-00 | | | 1.8 kΩ | 1/2 W | | |
| R335 | 321-0189-00 | | | 909 Ω | 1/8 W | Prec | 1% |
| R336 | 315-0331-00 | | | 330 Ω | 1/4 W | | 5% |
| R341 | 315-0103-00 | | | 10 kΩ | 1/4 W | | 5% |
| R342 | 301-0272-00 | | | 2.7 kΩ | 1/2 W | | 5% |
| R343 | 315-0183-00 | | | 18 kΩ | 1/4 W | | 5% |
| R344 | 302-0392-00 | | | 3.9 kΩ | 1/2 W | | |
| R346 | 316-0226-00 | | | 22 MΩ | 1/4 W | | |
| R347 | 315-0103-00 | | | 10 kΩ | 1/4 W | | 5% |
| R351 | 321-0289-00 | | | 10 kΩ | 1/8 W | Prec | 1% |
| R352 | 321-0397-00 | | | 133 kΩ | 1/8 W | Prec | 1% |
| R354 | 315-0683-00 | | | 68 kΩ | 1/4 W | | 5% |
| R355 | 321-0289-00 | | | 10 kΩ | 1/8 W | Prec | 1% |
| R358 | 321-0327-00 | | | 24.9 kΩ | 1/8 W | Prec | 1% |
| R359 | 323-0481-00 | | | 1 MΩ | 1/2 W | Prec | 1% |
| R360A | 311-0892-00 | 9500 | 14429 | 500 kΩ, Var | | | |
| R360A | 311-1274-00 | 14430 | | 500 kΩ, Var | | | |
| R360B | 311-0892-00 | 9500 | 14429 | 500 kΩ, Var | | | |
| R360B | 311-1274-00 | 14430 | | 500 kΩ, Var | | | |
| R360C | 311-0892-00 | 9500 | 14429 | 500 kΩ, Var | | | |
| R360C | 311-1274-00 | 14430 | | 500 kΩ, Var | | | |
| R360D | 311-0892-00 | 9500 | 14429 | 500 kΩ, Var | | | |
| R360D | 311-1274-00 | 14430 | | 500 kΩ, Var | | | |
| R361 | 323-0612-00 | | | 950 kΩ | 1/2 W | Prec | 1% |
| R362A | 315-0205-00 | | | 2 MΩ | 1/4 W | | 5% |
| R362B | 315-0125-00 | | | 1.2 MΩ | 1/4 W | | 5% |
| R362C | 315-0204-00 | | | 200 kΩ | 1/4 W | | 5% |
| R362D | 315-0105-00 | | | 1 MΩ | 1/4 W | | 5% |
| R363 | 315-0223-00 | | | 22 kΩ | 1/4 W | | 5% |
| R364 | 315-0683-00 | | | 68 kΩ | 1/4 W | | 5% |
| R365 | 321-0333-00 | | | 28.7 kΩ | 1/8 W | Prec | 1% |
| R368 | 321-0452-00 | | | 499 kΩ | 1/8 W | Prec | 1% |
| R369 | 315-0333-00 | | | 33 kΩ | 1/4 W | | 5% |
| R370 | 315-0204-00 | X10404 | | 200 kΩ | 1/4 W | | 5% |
| R371 | 316-0336-00 | | | 33 MΩ | 1/4 W | | |



©

**Resistors** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | |
|---|---|---|---|---|---|---|
| R372 | 316-0472-00 | | | 4.7 kΩ | 1/4 W | |
| R373 | 315-0224-00 | | | 220 kΩ | 1/4 W | 5% |
| R374 | 315-0103-00 | | | 10 kΩ | 1/4 W | 5% |
| R375 | 315-0473-00 | | | 47 kΩ | 1/4 W | 5% |
| R376 | 315-0272-00 | | | 2.7 kΩ | 1/4 W | 5% |
| R377 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R378 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R383 | 315-0224-00 | | | 220 kΩ | 1/4 W | 5% |
| R384 | 315-0103-00 | | | 10 kΩ | 1/4 W | 5% |
| R385 | 315-0473-00 | | | 47 kΩ | 1/4 W | 5% |
| R386 | 315-0272-00 | | | 2.7 kΩ | 1/4 W | 5% |
| R387 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R388 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R401 | 315-0471-00 | | | 470 Ω | 1/4 W | 5% |
| R402 | 323-0308-00 | | | 15.8 kΩ | 1/2 W Prec | 1% |
| R405 | 311-0360-01 | | | 5 kΩ, Var | | |
| R409 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | 5% |
| R411 | 315-0102-00 | | | 1 kΩ | 1/4 W | 5% |
| R412 | 315-0104-00 | | | 100 kΩ | 1/4 W | 5% |
| R413 | 315-0105-00 | | | 1 MΩ | 1/4 W | 5% |
| R414 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | 5% |
| R416 | 321-0452-00 | | | 499 kΩ | 1/8 W Prec | 1% |
| R417 | 323-0352-00 | | | 45.3 kΩ | 1/2 W Prec | 1% |
| R418 | 323-0304-00 | | | 14.3 kΩ | Selected (nominal value) | |
| R419 | 323-0424-00 | | | 255 kΩ | Selected (nominal value) | |
| R421 | 315-0154-00 | | | 150 kΩ | 1/4 W | 5% |
| R422 | 315-0123-00 | | | 12 kΩ | 1/4 W | 5% |
| R423 | 315-0154-00 | | | 150 kΩ | 1/4 W | 5% |
| R426 | 315-0563-00 | | | 56 kΩ | 1/4 W | 5% |
| R431 | 315-0223-00 | | | 22 kΩ | 1/4 W | 5% |
| R432 | 315-0823-00 | | | 82 kΩ | 1/4 W | 5% |
| R439 | 315-0101-00 | | | 100 Ω | 1/4 W | 5% |
| R441 | 315-0103-00 | | | 10 kΩ | 1/4 W | 5% |
| R442 | 315-0104-00 | | | 100 kΩ | 1/4 W | 5% |
| R443 | 315-0113-00 | X13730 | | 11 kΩ | 1/4 W | 5% |
| R445 | 302-0333-00 | | | 33 kΩ | 1/2 W | |
| R446 | 315-0104-00 | | | 100 kΩ | 1/4 W | 5% |
| R447 | 315-0393-00 | | | 39 kΩ | 1/4 W | 5% |
| R448 | 315-0104-00 | | | 100 kΩ | 1/4 W | 5% |
| R449 | 315-0104-00 | | | 100 kΩ | 1/4 W | 5% |
| R450 | 315-0104-00 | 9500 | 13729 | 100 kΩ | 1/4 W | 5% |
| R450 | 321-0385-00 | 13730 | | 100 kΩ | 1/8 W Prec | 1% |
| R451 | 315-0223-00 | 9500 | 13729 | 22 kΩ | 1/4 W | 5% |
| R451 | 321-0689-00 | 13730 | | 24.9 kΩ | 1/8 W Prec | 1% |
| R452 | 315-0223-00 | | | 22 kΩ | 1/4 W | 5% |
| R453 | 303-0223-00 | | | 22 kΩ | 1 W | 5% |
| R454 | 315-0563-00 | | | 56 kΩ | 1/4 W | 5% |
| R455 | 321-0258-00 | | | 4.75 kΩ | 1/8 W Prec | 1% |

**Resistors** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R456 | 321-0317-00 | | | 19.6 kΩ | 1/8 W | Prec | 1% |
| R457 | 321-0393-00 | | | 121 kΩ | 1/8 W | Prec | 1% |
| R458 | 311-0465-00 | 9500 | 14429 | 100 kΩ, Var | | | |
| R458 | 311-1235-00 | 14430 | | 100 kΩ, Var | | | |
| R460 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | | 5% |
| R461A | 321-0341-00 | | | 34.8 kΩ | 1/8 W | Prec | 1% |
| R461B | 321-0239-00 | | | 3.01 kΩ | 1/8 W | Prec | 1% |
| R461C | 321-0239-00 | | | 3.01 kΩ | 1/8 W | Prec | 1% |
| R461D | 321-0239-00 | | | 3.01 kΩ | 1/8 W | Prec | 1% |
| R461E | 321-0239-00 | | | 3.01 kΩ | 1/8 W | Prec | 1% |
| R461F | 321-0239-00 | | | 3.01 kΩ | 1/8 W | Prec | 1% |
| R461G | 321-0210-00 | | | 1.5 kΩ | 1/8 W | Prec | 1% |
| R461H | 311-0579-00 | | | 20 kΩ, Var | | | |
| R462 | 315-0272-00 | 9500 | 10069 | 2.7 kΩ | 1/4 W | | 5% |
| R462 | 301-0242-00 | 10070 | | 2.4 kΩ | 1/2 W | | 5% |
| R463 | 315-0471-00 | | | 470 Ω | 1/4 W | | 5% |
| R464 | 301-0433-00 | 9500 | 10835 | 43 kΩ | 1/2 W | | 5% |
| R464 | 323-0352-00 | 10836 | | 45.3 kΩ | 1/2 W | Prec | 1% |
| R465 | 315-0113-00 | | | 11 kΩ | 1/4 W | | 5% |
| R466 | 321-0335-00 | | | 30.1 kΩ | 1/8 W | Prec | 1% |
| R467 | 315-0512-00 | | | 5.1 kΩ | 1/4 W | | 5% |
| R468 | 323-0335-00 | | | 30.1 kΩ | 1/2 W | Prec | 1% |
| R469 | 301-0473-00 | | | 47 kΩ | 1/2 W | | 5% |
| R470 | 315-0113-00 | | | 11 kΩ | 1/4 W | | 5% |
| R472 | 316-0334-00 | | | 330 kΩ | 1/4 W | | |
| R473 | 315-0433-00 | | | 43 kΩ | 1/4 W | | 5% |
| R474 | 308-0168-00 | | | 40 kΩ | 8 W | WW | 5% |
| R475 | 316-0105-00 | | | 1 MΩ | 1/4 W | | |
| R476 | 315-0393-00 | | | 39 kΩ | 1/4 W | | 5% |
| R477 | 302-0273-00 | | | 27 kΩ | 1/2 W | | |
| R478 | 315-0223-00 | | | 22 kΩ | 1/4 W | | 5% |
| R479 | 315-0123-00 | | | 12 kΩ | 1/4 W | | 5% |
| R480 | 315-0103-00 | | | 10 kΩ | 1/4 W | | 5% |
| R480A | 308-0231-00 | | | 220 Ω | 3 W | WW | 5% |
| R480D | 308-0252-00 | | | 390 Ω | 3 W | WW | 5% |
| R481 | 321-0404-00 | | | 158 kΩ | 1/8 W | Prec | 1% |
| R482 | 321-0404-00 | | | 158 kΩ | 1/8 W | Prec | 1% |
| R483 | 323-0488-00 | | | 1.18 MΩ | 1/2 W | Prec | 1% |
| R484 | 321-0415-00 | | | 205 kΩ | 1/8 W | Prec | 1% |
| R485 | 316-0101-00 | X15000 | | 100 Ω | 1/4 W | | |
| R486 | 315-0822-00 | | | 8.2 kΩ | 1/4 W | | 5% |
| R487 | 301-0203-00 | | | 20 kΩ | 1/2 W | | 5% |
| R488 | 316-0103-00 | | | 10 kΩ | 1/4 W | | |
| R489 | 304-0183-00 | | | 18 kΩ | 1 W | | |
| R491 | 315-0512-00 | 9500 | 13729 | 5.1 kΩ | 1/4 W | | 5% |
| R491 | 301-0391-00 | 13730 | | 390 Ω | 1/2 W | | 5% |
| R492 | 321-0322-00 | | | 22.1 kΩ | 1/8 W | Prec | 1% |
| R493 | 323-0346-00 | 9500 | 13729 | 39.2 kΩ | 1/2 W | Prec | 1% |
| R493 | 323-0341-00 | 13730 | | 34.8 kΩ | 1/2 W | Prec | 1% |
| R494 | 311-0510-00 | 9500 | 14429 | 10 kΩ, Var | %S | | |
| R494 | 311-1228-00 | 14430 | | 10 kΩ, Var | | | |
| R495 | 316-0105-00 | 9500 | 10835 | 1 MΩ | 1/4 W | | |
| R495 | 315-0474-00 | 10836 | | 470 kΩ | 1/4 W | | |

## Resistors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R503 | 315-0224-00 | | | 220 kΩ | 1/4 W | | 5% |
| R505 | 311-0893-00 | 9500 | 14429 | 5 MΩ, Var | | | |
| R505 | 311-1257-00 | 14430 | | 5 MΩ, Var | | | |
| R507 | 323-0668-00 | | | 1.442 MΩ | 1/2 W | Prec | 1/4% |
| R508 | 323-0737-00 | 9500 | 11659 | 3.935 MΩ | 1/2 W | Prec | 1% |
| R508 | 325-0074-00 | 11660 | | 3.935 MΩ | 1 W | Prec | 1% |
| R510 | 301-0513-00 | | | 51 kΩ | 1/2 W | | 5% |
| R511 | 311-0465-00 | 9500 | 14429 | 100 kΩ, Var | | | |
| R511 | 311-1235-00 | 14430 | | 100 kΩ, Var | | | |
| R512 | 323-0498-00 | | | 1.5 MΩ | 1/2 W | Prec | 1% |
| R513 | 315-0475-00 | | | 4.7 MΩ | 1/4 W | | 5% |
| R514 | 315-0393-00 | | | 39 kΩ | 1/4 W | | 5% |
| R515 | 315-0125-00 | | | 1.2 MΩ | 1/4 W | | 5% |
| R516 | 321-0346-00 | | | 39.2 kΩ | 1/8 W | Prec | 1% |
| R518 | 323-0388-00 | | | 107 kΩ | 1/2 W | Prec | 1% |
| R519 | 301-0223-00 | | | 22 kΩ | 1/2 W | | 5% |
| R520 | 323-0437-00 | | | 348 kΩ | 1/2 W | Prec | 1% |
| R521 | 321-0249-00 | | | 3.83 kΩ | 1/8 W | Prec | 1% |
| R522 | 321-0316-00 | | | 19.1 kΩ | 1/8 W | Prec | 1% |
| R523 | 321-0382-00 | | | 93.1 kΩ | 1/8 W | Prec | 1% |
| R524 | 311-0326-00 | | | 10 kΩ, Var | | | |
| R525 | 323-0373-00 | | | 75 kΩ | 1/2 W | Prec | 1% |
| R526 | 321-0345-00 | | | 38.3 kΩ | 1/8 W | Prec | 1% |
| R527 | 321-0372-00 | | | 73.2 kΩ | 1/8 W | Prec | 1% |
| R528 | 311-0326-00 | | | 10 kΩ, Var | | | |
| R533 | 316-0224-00 | | | 220 kΩ | 1/4 W | | |
| R534 | 315-0222-00 | | | 2.2 kΩ | 1/4 W | | 5% |
| R535 | 315-0273-00 | | | 27 kΩ | 1/4 W | | 5% |
| R544 | 315-0683-00 | | | 68 kΩ | 1/4 W | | 5% |
| R550 | 315-0105-00 | X10071 | 10403 | 1 MΩ | 1/4 W | | 5% |
| R550 | 315-0104-00 | 10404 | 12279X | 100 kΩ | 1/4 W | | 5% |
| R552 | 301-0363-00 | | | 36 kΩ | 1/2 W | | 5% |
| R554 | 308-0178-00 | | | 15 kΩ | 8 W | WW | 5% |
| R555 | 315-0240-00 | | | 24 Ω | 1/2 W | | 5% |
| R556 | 323-0235-00 | | | 2.74 kΩ | 1/2 W | Prec | 1% |
| R557[3] | 311-0891-00 | 9500 | 12969 | 100 Ω, Var | | | |
| R557[3] | 311-1217-00 | 12970 | | 100 Ω, Var | | | |
| R558 | 315-0100-00 | | | 10 Ω | 1/4 W | | 5% |
| R559 | 316-0224-00 | | | 220 kΩ | 1/4 W | | |
| R564 | 308-0178-00 | | | 15 kΩ | 8 W | WW | 5% |
| R566 | 323-0235-00 | | | 2.74 kΩ | 1/2 W | Prec | 1% |
| R568 | 311-0433-00 | 9500 | 14429 | 100 Ω, Var | | | |
| R568 | 311-1222-00 | 14430 | | 100 Ω, Var | | | |
| R571 | 301-0363-00 | | | 36 kΩ | 1/2 W | | 5% |
| R574 | 315-0153-00 | | | 15 kΩ | 1/4 W | | 5% |
| R575 | 311-0462-00 | 9500 | 14429 | 1 kΩ, Var | | | |
| R575 | 311-1225-00 | 14430 | | 1 kΩ, Var | | | |
| R576 | 322-0261-00 | | | 5.11 kΩ | 1/4 W | Prec | 1% |
| R577 | 308-0429-00 | | | 22 kΩ | 3 W | WW | 1% |
| R578 | 321-0641-00 | | | 1.8 kΩ | 1/8 W | Prec | 1% |
| R579 | 311-0360-00 | | | 5 kΩ, Var | | | |
| R601 | 311-0377-00 | | | 25 Ω, Var | | | |
| R614 | 315-0242-00 | | | 2.4 kΩ | 1/4 W | | 5% |

[3]Furnished as a unit with SW557.

**Resistors** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | | |
|---|---|---|---|---|---|---|---|
| R616 | 315-0184-00 | | | 180 kΩ | ¼ W | | 5% |
| R617 | 315-0471-00 | | | 470 Ω | ¼ W | | 5% |
| R618 | 315-0183-00 | | | 18 kΩ | ¼ W | | 5% |
| R620 | 311-0510-00 | 9500 | 14429 | 10 kΩ, Var | | | |
| R620 | 311-1228-00 | 14430 | | 10 kΩ, Var | | | |
| R621 | 302-0122-00 | 9500 | 10835X | 1.2 kΩ | ½ W | | |
| R624 | 321-0206-00 | | | 1.37 kΩ | ⅛ W | Prec | 1% |
| R625 | 315-0103-00 | | | 10 kΩ | ¼ W | | 5% |
| R626 | 321-0233-00 | | | 2.61 kΩ | ⅛ W | Prec | 1% |
| R634 | 304-0223-00 | | | 22 kΩ | 1 W | | |
| R637 | 302-0102-00 | | | 1 kΩ | ½ W | | |
| R640 | 307-0007-00 | | | 2.7 Ω | 1 W | | |
| R641 | 323-0335-00 | | | 30.1 kΩ | ½ W | Prec | 1% |
| R642 | 321-0277-00 | | | 7.5 kΩ | ⅛ W | Prec | 1% |
| R643 | 315-0104-00 | | | 100 kΩ | ¼ W | | 5% |
| R644 | 316-0102-00 | | | 1 kΩ | ¼ W | | |
| R645 | 308-0212-00 | | | 10 kΩ | 3 W | WW | 5% |
| R646 | 316-0221-00 | | | 220 Ω | ¼ W | | |
| R647 | 304-0120-00 | | | 12 Ω | 1 W | | |
| R649 | 316-0221-00 | | | 220 Ω | ¼ W | | |
| R650 | 307-0009-00 | | | 4.7 Ω | 1 W | | |
| R651 | 324-0415-00 | | | 205 kΩ | 1 W | Prec | 1% |
| R652 | 308-0212-00 | 9500 | 10129 | 10 kΩ | 3 W | WW | 5% |
| R652 | 304-0124-00 | 10130 | | 120 kΩ | 1 W | | |
| R653 | 323-0306-00 | | | 15 kΩ | ½ W | Prec | 1% |
| R654 | 316-0102-00 | | | 1 kΩ | ¼ W | | |
| R655 | 311-0317-00 | | | 2 x 1 kΩ, Var | | | |
| R656 | 302-0102-00 | 9500 | 14059 | 1 kΩ | ½ W | | |
| R656 | 301-0911-00 | 14060 | | 910 Ω | ½ W | | 5% |
| R657 | 315-0104-00 | | | 100 kΩ | ¼ W | | 5% |
| R658 | 316-0221-00 | | | 220 Ω | ¼ W | | |
| R659 | 304-0120-00 | | | 12 kΩ | 1 W | | |
| R800 | 302-0101-00 | | | 100 Ω | ½ W | | |
| R802 | 316-0101-00 | | | 100 Ω | ¼ W | | |
| R803 | 308-0168-00 | | | 40 kΩ | 8 W | WW | 5% |
| R806 | 323-0471-01 | | | 787 kΩ | ½ W | Prec | ½% |
| R808 | 302-0102-00 | | | 1 kΩ | ½ W | | |
| R809 | 316-0105-00 | | | 1 MΩ | ¼ W | | |
| R810 | 316-0101-00 | | | 100 Ω | ¼ W | | |
| R814 | 311-0252-00 | | | 1 MΩ, Var | | | |
| R816 | 321-1485-00 | | | 1.11 MΩ | ⅛ W | Prec | 1% |
| R818 | 315-0273-00 | | | 27 kΩ | ¼ W | | 5% |
| R819 | 321-0414-00 | | | 200 kΩ | ⅛ W | Prec | 1% |
| R821 | 321-0249-00 | | | 3.83 kΩ | ⅛ W | Prec | 1% |
| R832 | 302-0104-00 | | | 100 kΩ | ½ W | | |
| R833 | 306-0106-00 | | | 10 MΩ | 2 W | | |
| R837 | 305-0685-00 | | | 6.8 MΩ | 2 W | | 5% |
| R838 | 305-0685-00 | | | 6.8 MΩ | 2 W | | 5% |

## Resistors *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | Description | | |
|---|---|---|---|---|---|---|
| R839 | 305-0685-00 | | | 6.8 MΩ | 2 W | 5% |
| R840 | 315-0104-00 | X14648 | | 100 kΩ, | 1/4 W | 5% |
| R841 | 305-0565-00 | | | 5.6 MΩ | 2 W | 5% |
| R842 | 305-0565-00 | | | 5.6 MΩ | 2 W | 5% |
| R843 | 305-0565-00 | | | 5.6 MΩ | 2 W | 5% |
| R844 | 311-0505-01 | | | 10 MΩ, Var | | |
| R845 | 305-0685-00 | | | 6.8 MΩ | 2 W | 5% |
| R846 | 311-0043-02 | | | 2 MΩ, Var | | |
| R847 | 302-0824-00 | 9500 | 11699 | 820 kΩ | 1/2 W | |
| R847 | 302-0394-00 | 11700 | | 390 kΩ | 1/2 W | |
| R848 | 311-0174-00 | | | 3.5 MΩ, Var | | |
| R849 | 302-0155-00 | | | 1.5 MΩ | 1/2 W | |
| R850 | 301-0102-00 | | | 1 kΩ | 1/2 W | 5% |
| R851 | 316-0104-00 | | | 100 kΩ | 1/4 W | |
| R855 | 311-0892-00 | 9500 | 14429 | 500 kΩ, Var | | |
| R855 | 311-1274-00 | 14430 | | 500 kΩ, Var | | |
| R856 | 315-0114-00 | | | 110 kΩ | 1/4 W | 5% |
| R857 | 315-0223-00 | | | 22 kΩ | 1/4 W | 5% |
| R864 | 311-0552-00 | 9500 | 14429 | 1 MΩ, Var | | |
| R864 | 311-1254-00 | 14430 | | 1 MΩ, Var | | |
| R865 | 316-0184-00 | | | 180 kΩ | 1/4 W | |
| R866 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R874 | 304-0273-00 | | | 27 kΩ | 1 W | |
| R875 | 316-0393-00 | | | 39 kΩ | 1/4 W | |
| R876 | 316-0152-00 | | | 1.5 kΩ | 1/4 W | |
| R881 | 321-0327-00 | | | 24.9 kΩ | 1/8 W Prec | 1% |
| R882 | 321-0146-00 | | | 324 Ω | 1/8 W Prec | 1% |
| R883 | 321-0191-00 | | | 953 Ω | 1/8 W Prec | 1% |
| R885 | 321-0141-00 | | | 287 Ω | 1/8 W Prec | 1% |
| R886 | 321-0014-00 | | | 13.7 Ω | 1/8 W Prec | 1% |
| R887 | 321-0178-00 | | | 698 Ω | 1/8 W Prec | 1% |
| R1347 | 315-0103-00 | | | 10 kΩ | 1/4 W | 5% |
| R1373 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R1374 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | 5% |
| R1375 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1376 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R1377 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1378 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1383 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R1384 | 315-0472-00 | | | 4.7 kΩ | 1/4 W | 5% |
| R1385 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1386 | 316-0105-00 | | | 1 MΩ | 1/4 W | |
| R1387 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1388 | 316-0473-00 | | | 47 kΩ | 1/4 W | |
| R1389 | 316-0473-00 | | | 47 kΩ | 1/4 W | |

## Switches

| | Wired or Unwired | | | | |
|---|---|---|---|---|---|
| SW101 | Wired *262-0861-00 | | | Rotary | INPUT |
| SW101 | 260-1016-00 | | | Rotary | INPUT |
| SW118 | Wired *262-0687-00 | 9500 | 12599 | Rotary | VOLTS FULL SCALE |
| SW118 | Wired *262-0687-02 | 12600 | 12979 | Rotary | VOLTS FULL SCALE |
| SW118 | Wired *262-0687-03 | 12980 | | Rotary | VOLTS FULL SCALE |
| SW118 | 260-0654-00 | 9500 | 12599 | Rotary | VOLTS FULL SCALE |
| SW118 | 260-0654-02 | 12600 | | Rotary | VOLTS FULL SCALE |
| SW135 | Wired *262-0864-00 | | | Rotary | RESPONSE |

**Switches** *(cont)*

| Ckt. No. | Tektronix Part No. | Serial/Model No. Eff | Disc | | Description |
|---|---|---|---|---|---|
| SW135 | 260-0915-01 | | | Rotary | RESPONSE |
| SW240[4] | 311-0506-00 | 9500 | 12599 | | |
| SW240[4] | 311-0506-01 | 12600 | 12979 | | |
| SW240[4] | 311-1219-00 | 12980 | | | |
| SW290 | 260-0473-00 | | | Lever | DC RESTORER |
| SW305 | 260-0473-00 | | | Lever | SYNC |
| SW380 | 260-0640-00 | | | Lever | FIELD SHIFT |
| SW430 | Wired *262-0860-00 | | | Rotary | DISPLAY |
| SW430[5] | 260-1015-00 | | | Rotary | DISPLAY |
| SW461 | Wired *262-0865-00 | | | Rotary | LINE SELECTRO |
| SW461 | 260-0793-00 | | | Rotary | LINE SELECTRO |
| SW480[6] | | | | Lever | LINE AND FIELD RATE |
| SW510 | 260-0723-00 | | | Slide | STAIRSTEP SELECTOR |
| SW520 | Wired *262-0862-00 | 9500 | 12969 | Rotary | MAGNIFIER |
| SW520 | Wired *262-0862-01 | 12970 | | Rotary | MAGNIFIER |
| SW520 | 260-1017-00 | 9500 | 12969 | Rotary | MAGNIFIER |
| SW520 | 260-1017-01 | 12970 | | Rotary | MAGNIFIER |
| SW557[7] | 311-0891-00 | 9500 | 12969 | | |
| SW557[7] | 311-1217-00 | 12970 | | | |
| SW601 | 260-0199-00 | 9500 | 12219 | Toggle | POWER |
| SW601 | 260-0276-00 | 12220 | | Toggle | POWER |
| SW885 | 260-0546-00 | | | Lever | CALIBRATOR |
| SW1380 | 260-0396-00 | | | Toggle | PAL FRAME SELECTOR |
| **Transformers** | | | | | |
| T280 | *120-0573-00 | | | Toroid, 4 windings | |
| T601 | *120-0577-00 | | | L.V. Power | |
| T801 | *120-0572-00 | | | H.V. Power | |
| **Test Points** | | | | | |
| TP325 | *214-0579-00 | | | Pin, test point | |
| TP335 | *214-0579-00 | | | Pin, test point | |
| TP344 | *214-0579-00 | | | Pin, test point | |
| TP347 | *214-0579-00 | | | Pin, test point | |
| TP370 | *214-0579-00 | | | Pin, test point | |
| TP377 | *214-0579-00 | | | Pin, test point | |
| TP415 | *214-0579-00 | | | Pin, test point | |
| TP452 | *214-0579-00 | | | Pin, test point | |
| TP474 | *214-0579-00 | | | Pin, test point | |
| TP481 | *214-0579-00 | | | Pin, test point | |
| TP1377 | *214-0579-00 | | | Pin, test point | |
| **Electron Tubes** | | | | | |
| V113A,B | *157-0010-00 | | | 12AT7 checked, aged | |
| V164 | 154-0420-00 | | | 7788/E 810F | |
| V264 | 154-0420-00 | | | 7788/E 810F | |
| V293A,B | 154-0039-00 | | | 12AT7 | |
| V800A,B | 154-0468-00 | | | 6GV8-ECL85 | |
| V859 | *154-0514-00 | 9500 | 14049 | T5291-31 | CRT Standard Phosphor |
| V859 | *154-0514-10 | 14050 | | T5291-31 | CRT Standard Phosphor |

[4]Furnished as a unit with R240.
[5]Furnished as a unit with SW480.
[6]Furnished as a unit with SW430.
[7]Furnished as a unit with R557.

## FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

## INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

*Assembly and/or Component*
*Detail Part of Assembly and/or Component*
*mounting hardware for Detail Part*
*Parts of Detail Part*
*mounting hardware for Parts of Detail Part*
*mounting hardware for Assembly and/or Component*

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

**Mounting hardware must be purchased separately, unless otherwise specified.**

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

## ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

## INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 FRONT
FIG. 2 CHASSIS
FIG. 3 CRT & REAR

# SECTION 7
# MECHANICAL PARTS LIST

## FIG. 1 FRONT

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 1-1 | 333-1073-01 | | | 1 | | PANEL, front |
| -2 | 366-0109-00 | | | 2 | | KNOB, plug-in securing |
| | - - - - - - | | | - | | each knob includes: |
| | 213-0005-00 | | | 1 | | SCREW, set, 8-32 x 1/8 inch, HHS |
| -3 | 214-0425-00 | | | 1 | | FASTENER, left |
| | - - - - - - | | | - | | mounting hardware: (not included w/fastener) |
| -4 | 210-0004-00 | | | 2 | | LOCKWASHER, internal, #4 |
| -5 | 210-0406-00 | | | 2 | | NUT, hex., 4-40 x 3/16 inch |
| -6 | 214-0424-00 | | | 1 | | FASTENER, right |
| | - - - - - - | | | - | | mounting hardware: (not included w/fastener) |
| -7 | 210-0004-00 | | | 2 | | LOCKWASHER, internal, #4 |
| -8 | 210-0406-00 | | | 2 | | NUT, hex., 4-40 x 3/16 inch |
| -9 | 367-0022-00 | | | 2 | | HANDLE |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/handle) |
| | 213-0090-00 | | | 2 | | SCREW, 10-32 x 1/2 inch, HHS |
| -10 | 366-0215-01 | | | 1 | | KNOB, charcoal, lever—DC RESTORER |
| -11 | 260-0473-00 | | | 1 | | SWITCH, lever—DC RESTORER |
| | - - - - - - | | | - | | mounting hardware: (not included w/switch) |
| -12 | 220-0413-00 | | | 2 | | NUT, hex., 4-40 x 0.562 inch |
| -13 | 366-0215-01 | | | 1 | | KNOB, charcoal, lever—CALIBRATOR |
| -14 | 260-0546-00 | | | 1 | | SWITCH, lever—CALIBRATOR |
| | - - - - - - | | | - | | mounting hardware: (not included w/switch) |
| | 220-0413-00 | | | 1 | | NUT, hex., 4-40 x 0.562 inch |
| -15 | 366-0322-01 | | | 1 | | KNOB, charcoal—INPUT |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -16 | 384-0342-00 | | | 1 | | ROD, extension |
| -17 | 358-0029-00 | | | 3 | | BUSHING |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/bushing) |
| -18 | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |
| -19 | 376-0011-00 | | | 2 | | COUPLING, insulating |
| | - - - - - - | | | - | | each coupling includes: |
| | 213-0048-00 | | | 2 | | SCREW, set, 4-40 x 1/8 inch, HSS |

## FIG. 1 FRONT *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty 1 2 3 4 5 | Description |
|---|---|---|---|---|---|
| 1-20 | 262-0861-00 | | | 1 | SWITCH, wired—INPUT |
| | - - - - - - | | | - | switch includes: |
| | 260-1016-00 | | | 1 | SWITCH, unwired |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -21 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0840-00 | | | 1 | WASHER, flat, 0.390 ID x 9/16 inch OD |
| -22 | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| -23 | 366-0322-01 | | | 1 | KNOB, charcoal—RESPONSE |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -24 | 384-0030-00 | | | 1 | ROD, extension |
| -25 | 262-0860-00 | | | 1 | SWITCH, wired—RESPONSE |
| | - - - - - - | | | - | switch includes: |
| | 260-1015-00 | | | 1 | SWITCH, unwired |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -26 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0840-00 | | | 1 | WASHER, flat, 0.390 ID x 9/16 inch OD |
| -27 | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| -28 | 366-0173-00 | | | 1 | KNOB, charcoal—POSITION |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| -29 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| -30 | 210-0207-00 | | | 1 | LUG, solder, 3/8 ID x 5/8 inch OD, SE |
| -31 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -32 | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| -33 | 366-0153-00 | | | 1 | KNOB, charcoal—VARIABLE |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -34 | 366-0322-00 | | | 1 | KNOB, charcoal—VOLTS FULL SCALE |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -35 | 262-0687-00 | 101 | 12599 | 1 | SWITCH, wired—VOLTS FULL SCALE |
| | 262-0687-02 | 12600 | 12979 | 1 | SWITCH, wired—VOLTS FULL SCALE |
| | 262-0687-03 | 12980 | | 1 | SWITCH, wired—VOLTS FULL SCALE |
| | - - - - - - | | | - | switch includes: |
| | 260-0654-00 | 101 | 12599 | 1 | SWITCH, unwired |
| | 260-0654-02 | 12600 | | 1 | SWITCH, unwired |
| -36 | 384-0260-00 | | | 1 | ROD, extension |
| -37 | 376-0014-00 | | | 1 | COUPLING |
| -38 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| -39 | 210-0012-00 | 101 | 12599 | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0012-00 | 12600 | | 2 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -40 | 210-0413-00 | 101 | 12599 | 2 | NUT, hex., 3/8-32 x 1/2 inch |
| | 220-0495-00 | 12600 | | 2 | NUT, hex., 3/8-32 x 1/2 inch |
| | 210-0406-00 | X12600 | | 2 | NUT, hex., 4-40 x 3/16 inch |
| | 210-0004-00 | X12600 | | 2 | LOCKWASHER, internal, #4 |
| | 426-0289-00 | X12600 | | 1 | FRAME, plastic |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -41 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0840-00 | | | 1 | WASHER, flat, 0.390 ID x 9/16 inch OD |
| -42 | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |



®

**FIG. 1 FRONT** *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 1-43 | 407-0078-01 | | | 1 | | BRACKET, switch & circuit board |
| | - - - - - - | | | - | | mounting hardware: (not included w/bracket) |
| -44 | 211-0507-00 | | | 2 | | SCREW, 6-32 x 5/16 inch, PHS |
| | 210-0457-00 | | | 2 | | NUT, 6-32 x 5/16 inch |
| -45 | 366-0148-00 | | | 1 | | KNOB, charcoal—FOCUS |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -46 | - - - - - - | | | 2 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/resistor) |
| -47 | 210-0013-00 | | | 1 | | LOCKWASHER, internal, 3/8 ID x 11/16 inch OD |
| | 210-0840-00 | | | 1 | | WASHER, flat 0.390 ID x 9/16 inch OD |
| -48 | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |
| -49 | 200-0745-00 | | | 2 | | COVER, plastic |
| -50 | - - - - - - | | | 1 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware: (not include w/resistor) |
| -51 | 210-0413-00 | | | 2 | | NUT, hex., 3/8-32 x 1/2 inch |
| -52 | 210-0012-00 | | | 1 | | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -53 | 366-0148-00 | | | 1 | | KNOB, charcoal—INTENSITY |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -54 | 366-0148-00 | | | 1 | | KNOB, charcoal—SCALE ILLUM |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -55 | 366-0322-01 | | | 1 | | KNOB, charcoal—POSITION |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -56 | - - - - - - | | | 1 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware: (not included w/resistor) |
| -57 | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |
| -58 | 366-0153-00 | | | 1 | | KNOB, charcoal—LINE & FIELD RATE |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -59 | 366-0322-00 | | | 1 | | KNOB, charcoal—DISPLAY |
| | - - - - - - | | | - | | knob includes: |
| | 213-0004-00 | | | 1 | | SCREW, set, 6-32 x 3/16 inch, HSS |
| -60 | 262-0864-00 | | | 1 | | SWITCH, wired—DISPLAY |
| | - - - - - - | | | - | | switch includes: |
| | 260-0915-01 | | | 1 | | SWITCH, unwired |
| | 131-0371-00 | | | 8 | | CONNECTOR, terminal, female |
| -61 | 179-0952-01 | | | 1 | | CABLE HARNESS |
| | - - - - - - | | | - | | cable harness includes: |
| | 131-0371-00 | | | 8 | | CONNECTOR, terminal, female |
| | - - - - - - | | | - | | mounting hardware: (not included w/switch) |
| | 210-0012-00 | | | 1 | | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -62 | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |

## FIG. 1 FRONT *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description 1 2 3 4 5 |
|---|---|---|---|---|---|
| 1-63 | 366-0153-00 | | | 1 | KNOB, charcoal—VARIABLE |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -64 | 366-0322-00 | | | 1 | KNOB, charcoal—MAGNIFIER |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -65 | 262-0862-00 | 101 | 12969 | 1 | SWITCH, wired—MAGNIFIER |
| | 262-0862-01 | 12970 | | 1 | SWITCH, wired—MAGNIFIER |
| | - - - - - - | | | - | switch includes: |
| | 260-1017-00 | 101 | 12969 | 1 | SWITCH, unwired |
| | 260-1017-01 | 12970 | | 1 | SWITCH, unwired |
| -66 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| -67 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0840-00 | | | 1 | WASHER, flat, 0.390 ID x 9/16 inch OD |
| -68 | 210-0590-00 | | | 1 | NUT, hex., 3/8-32 x 7/16 inch |
| | 210-0406-00 | X12970 | | 2 | NUT, hex., 4-40 x 3/16 inch |
| | 210-0004-00 | X12970 | | 2 | LOCKWASHER, internal, #4 |
| | 426-0289-00 | X12970 | | 1 | FRAME, plastic |
| -69 | 348-0055-00 | | | 1 | GROMMET, plastic, 1/4 inch diameter |
| -70 | - - - - - - | | | 2 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware for each: (not included w/resistor) |
| | 210-0940-00 | | | 1 | WASHER, flat, 1/4 ID x 3/8 inch OD |
| -71 | 210-0583-00 | | | 1 | NUT, hex., 1/4-32 x 5/16 inch |
| -72 | 407-0497-03 | | | 1 | BRACKET |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -73 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| -74 | 366-0153-00 | | | 1 | KNOB, charcoal—VARIABLE |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -75 | 366-0322-00 | | | 1 | KNOB, charcoal—LINE SELECTOR |
| | - - - - - - | | | - | knob includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch, HSS |
| -76 | 262-0865-00 | | | 1 | SWITCH, wired—LINE SELECTOR |
| | - - - - - - | | | - | switch includes: |
| | 260-0793-00 | | | 1 | SWITCH, unwired |
| -77 | 384-0408-00 | | | 1 | ROD, extension |
| -78 | 348-0055-00 | | | 1 | GROMMET, plastic, 1/4 inch diameter |
| -79 | 407-0497-02 | | | 1 | BRACKET |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| | 210-0801-00 | | | 2 | WASHER, flat, 0.140 ID x 0.281 inch OD |
| -80 | 426-0289-00 | | | 1 | MOUNT, plastic |
| | 210-0004-00 | | | 2 | LOCKWASHER, internal, #4 |
| -81 | 210-0406-00 | | | 2 | NUT, hex., 4-40 x 3/16 inch |
| -82 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| -83 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -84 | 210-0840-00 | | | 1 | WASHER, flat, 0.390 ID x 9/16 inch OD |
| | 210-0590-00 | | | 1 | NUT, hex., 3/8-32 x 7/16 inch |

## FIG. 1 FRONT *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description 1 2 3 4 5 |
|---|---|---|---|---|---|
| 1-85 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| | 210-0940-00 | | | 1 | WASHER, flat, 1/4 ID x 3/8 inch OD |
| -86 | 210-0583-00 | | | 1 | NUT, hex., 1/4-32 x 5/16 inch |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -87 | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -88 | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| -89 | 366-0215-01 | | | 1 | KNOB, charcoal, lever—FIELD |
| -90 | 260-0640-00 | | | 1 | SWITCH, lever—FIELD |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -91 | 220-0413-00 | | | 2 | NUT, hex., 4-40 x 0.562 inch |
| -92 | 366-0215-01 | | | 1 | KNOB, charcoal, lever—SYNC |
| -93 | 260-0473-00 | | | 1 | SWITCH, lever—SYNC |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -94 | 220-0413-00 | | | 2 | NUT, hex., 4-40 x 0.562 inch |
| -95 | 260-0396-00 | | | 1 | SWITCH, toggle—PAL FRAME SELECTOR |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -96 | 210-0046-00 | | | 1 | LOCKWASHER, internal, 0.261 ID x 0.400 inch OD |
| | 210-0940-00 | | | 1 | WASHER, flat, 1/4 ID x 3/8 inch OD |
| -97 | 210-0562-00 | | | 1 | NUT, hex., 1/4-40 x 5/16 inch |
| -98 | - - - - - - | | | 1 | RESISTOR, variable |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| | 210-0046-00 | | | 1 | LOCKWASHER, internal, 0.261 ID x 0.400 inch OD |
| -99 | 210-0471-00 | | | 1 | NUT, hex., 1/4-32 x 5/16 diameter x 19/32 inch long |
| -100 | 210-0223-00 | | | 1 | LUG, solder, 1/4 ID x 7/16 inch OD, SE |
| -101 | 358-0054-00 | | | 1 | BUSHING |
| -102 | 352-0067-00 | | | 3 | HOLDER, plastic, neon, single |
| | - - - - - - | | | - | mounting hardware for each: (not included w/holder) |
| -103 | 211-0109-00 | | | 1 | SCREW, 4-40 x 7/8 inch, 100° csk, FHS |
| -104 | 210-0406-00 | | | 1 | NUT, hex., 4-40 x 3/16 inch |
| -105 | 260-0199-00 | 101 | 12219 | 1 | SWITCH, toggle—POWER |
| | 260-0276-00 | 12220 | | 1 | SWITCH, toggle—POWER |
| | - - - - - - | | | - | mounting hardware: (not included w/switch) |
| -106 | 210-0414-00 | | | 1 | NUT, hex., 15/32-32 x 9/16 inch |
| -107 | 354-0055-00 | | | 1 | RING, locking, 15/32 ID x 23/32 inch OD |
| | 210-0902-00 | | | 1 | WASHER, flat, 0.470 ID x 21/32 inch OD |
| -108 | 210-0473-00 | | | 1 | NUT, 12 sided, 15/32-32 x 5/64 inch |

## FIG. 1 FRONT *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 1-109 | - - - - - - | | | 1 | | RESISTOR |
| | - - - - - - | | | - | | mounting hardware: (not included w/resistor) |
| -110 | 210-0012-00 | | | 2 | | LOCKWASHER, internal, 3/8 ID x 1/2 inch OD |
| -111 | 220-0420-00 | | | 1 | | NUT, adapter |
| -112 | 358-0054-00 | | | 1 | | BUSHING |
| -113 | - - - - - - | | | - | | SEE STANDARD ACCESSORIES |
| -114 | 200-0272-00 | | | 1 | | COVER, graticule |
| | - - - - - - | | | - | | mounting hardware: (not included w/cover) |
| -115 | 210-0434-00 | | | 4 | | NUT, knurled, 10-32 x 0.515 x 3/8 inch |
| -116 | 378-0541-00 | | | 3 | | FILTER, lens, neon light |
| -117 | 352-0141-00 | | | 1 | | HOLDER, lamp |
| | - - - - - - | | | - | | mounting hardware: (not included w/holder) |
| -118 | 210-0457-00 | | | 2 | | NUT, keps, 6-32 x 5/16 inch |
| -119 | 386-1415-00 | | | 1 | | PLATE, subpanel front |
| | - - - - - - | | | - | | mounting hardware: (not included w/plate) |
| -120 | 212-0070-00 | | | 4 | | SCREW, 8-32 x 5/16 inch, 100° csk, FHS |
| | 210-0458-00 | | | 4 | | NUT, keps, 8-32 x 11/32 inch |
| -121 | 211-0538-00 | | | 4 | | SCREW, 6-32 x 5/16 inch, 100° csk, FHS |
| -122 | 343-0089-00 | | | 1 | | CLAMP, cable, plastic |
| -123 | 407-0081-00 | | | 1 | | BRACKET, CRT shield, left |
| | - - - - - - | | | - | | mounting hardware: (not included w/bracket) |
| -124 | 212-0004-00 | | | 2 | | SCREW, 8-32 x 5/16 inch, PHS |
| -125 | 212-0070-00 | | | 2 | | SCREW, 8-32 x 5/16 inch, 100° csk, FHS |
| -126 | 210-0458-00 | | | 2 | | NUT, keps, 8-32 x 11/32 inch |
| -127 | 407-0080-00 | | | 1 | | BRACKET, CRT shield, right |
| | - - - - - - | | | - | | mounting hardware: (not included w/bracket) |
| -128 | 212-0004-00 | | | 2 | | SCREW, 8-32 x 5/16 inch, PHS |
| -129 | 212-0070-00 | | | 2 | | SCREW, 8-32 x 5/16 inch, 100° csk, FHS |
| -130 | 210-0458-00 | | | 2 | | NUT, keps, 8-32 x 11/32 inch |
| -131 | 407-0079-01 | | | 1 | | BRACKET, switch, rear |
| | - - - - - - | | | - | | mounting hardware: (not included w/switch) |
| | 211-0538-00 | | | 2 | | SCREW, 6-32 x 5/16 inch, 100° csk, FHS |
| | 211-0507-00 | | | 1 | | SCREW, 6-32 x 5/16 inch, PHS |
| -132 | 210-0457-00 | | | 3 | | NUT, keps, 6-32 x 5/16 inch |

## FIG. 1 FRONT *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 1-133 | 348-0031-00 | | | 2 | | GROMMET, plastic, $^{3}/_{32}$ inch diameter |
| -134 | 337-1161-00 | | | 1 | | SHIELD, plastic |
| -135 | 337-1162-00 | | | 2 | | SHIELD, plastic |
| -136 | 337-1127-00 | | | 1 | | SHIELD, high voltage |
| | - - - - - - | | | - | | mounting hardware: (not included w/shield) |
| -137 | 211-0507-00 | | | 2 | | SCREW, 6-32 x $^{5}/_{16}$ inch, PHS |
| -138 | 129-0006-00 | | | 4 | | POST, connecting, insulated |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/post) |
| -139 | 210-0006-00 | | | 1 | | LOCKWASHER, internal, #6 |
| -140 | 348-0055-00 | | | 1 | | GROMMET, plastic, $^{1}/_{4}$ inch diameter |
| -141 | 348-0064-00 | | | 2 | | GROMMET, plastic, $^{5}/_{8}$ inch diameter |
| -142 | - - - - - - | | | 1 | | RESISTOR |
| | - - - - - - | | | - | | mounting hardware: (not included w/resistor) |
| -143 | 211-0553-00 | | | 1 | | SCREW, 6-32 x 1 $^{1}/_{2}$ inches, RHS |
| -144 | 210-0601-00 | | | 1 | | EYELET |
| -145 | 210-0478-00 | | | 1 | | NUT, hex., $^{5}/_{16}$ x $^{21}/_{32}$ inch long |
| -146 | 210-0507-00 | | | 1 | | SCREW, 6-32 x $^{5}/_{16}$ inch, PHS |
| -147 | 386-1534-00 | | | 1 | | PLATE, bulkhead |
| | - - - - - - | | | - | | mounting hardware: (not included w/plate) |
| | 212-0070-00 | | | 4 | | SCREW, 8-32 x $^{5}/_{16}$ inch, 100° csk, FHS |
| | 212-0004-00 | | | 2 | | SCREW, 8-32 x $^{5}/_{16}$ inch, PHS |
| -148 | 210-0458-00 | | | 6 | | NUT, keps, 8-32 x $^{11}/_{32}$ inch |
| -149 | 670-0602-00 | | | 1 | | ASSEMBLY, circuit board—HIGH & LOW PASS FILTER |
| | - - - - - - | | | - | | assembly includes: |
| | 388-0906-00 | | | 1 | | BOARD, circuit |
| | - - - - - - | | | - | | mounting hardware: (not included w/board) |
| -150 | 211-0116-00 | | | 4 | | SCREW, sems, 4-40 x $^{5}/_{16}$ inch, PHB |

## FIG. 2 CHASSIS

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 2-1 | 441-0600-02 | | | 1 | | CHASSIS, vertical |
| | - - - - - - | | | - | | mounting hardware: (not included w/chassis) |
| | 212-0004-00 | | | 5 | | SCREW, 8-32 x 5/16 inch, PHS |
| -2 | 212-0070-00 | | | 5 | | SCREW, 8-32 x 5/16 inch, FHS |
| | 210-0458-00 | | | 2 | | NUT, keps, 8-32 x 11/32 inch |
| -3 | 124-0167-00 | | | 1 | | STRIP, rubber |
| -4 | 348-0056-00 | | | 1 | | GROMMET, plastic, 3/8 inch |
| -5 | 348-0055-00 | | | 1 | | GROMMET, plastic, 1/4 inch |
| -6 | - - - - - - | | | 6 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/resistor) |
| | 210-0840-00 | | | 1 | | WASHER, 0.390 ID x 9/16 inch OD |
| -7 | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |
| -8 | - - - - - - | | | 1 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware: (not included w/resistor) |
| -9 | 210-0207-00 | | | 1 | | LUG, solder, 3/8 ID x 5/8 inch OD, SE |
| -10 | 210-0840-00 | | | 1 | | WASHER, 0.390 ID x 9/16 inch OD |
| | 210-0413-00 | | | 1 | | NUT, hex., 3/8-32 x 1/2 inch |
| -11 | - - - - - - | | | 2 | | RESISTOR, variable |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/resistor) |
| | 210-0940-00 | | | 1 | | WASHER, flat, 1/4 ID x 3/8 inch OD |
| -12 | 210-0583-00 | | | 1 | | NUT, hex., 1/4-32 x 5/16 inch |
| -13 | - - - - - - | | | 2 | | COIL |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/coil) |
| -14 | 213-0054-00 | | | 1 | | SCREW, thread cutting, 6-32 x 5/16 inch, PHS |
| -15 | 426-0121-00 | | | 1 | | MOUNT, toroid |
| | - - - - - - | | | - | | mounting hardware: (not included w/mount) |
| -16 | 361-0007-00 | | | 1 | | SPACER, plastic, 0.188 inch long |
| -17 | 131-0183-00 | | | 1 | | CONNECTOR, terminal feed-through |
| | - - - - - - | | | - | | mounting hardware: (not included w/connector) |
| | 358-0136-00 | | | 1 | | BUSHING, plastic |
| -18 | - - - - - - | | | 2 | | CAPACITOR |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/capacitor) |
| -19 | 214-0153-00 | | | 1 | | FASTENER, snap |
| -20 | 210-0201-00 | | | 12 | | LUG, solder, SE #4 |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/lug) |
| -21 | 213-0044-00 | | | 1 | | SCREW, thread forming, 5-32 x 3/16 inch, PHS |

## FIG. 2 CHASSIS *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description 1 2 3 4 5 |
|---|---|---|---|---|---|
| 2-22 | 210-0204-00 | | | 3 | LUG, solder, DE #6 |
| | - - - - - - | | | - | mouning hardware for each: (not included w/lug) |
| | 213-0044-00 | | | 1 | SCREW, thread forming, 5/32 x 3/16 inch, PHS |
| -23 | 385-0138-00 | | | 2 | ROD, plastic, 1 5/8 inches long |
| | - - - - - - | | | - | mounting hardware for each: (not included w/rod) |
| -24 | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, PHS |
| -25 | 136-0181-00 | | | 14 | SOCKET, transistor, 3 pin |
| | - - - - - - | | | - | mounting hardware for each: (not included w/socket) |
| -26 | 354-0234-00 | | | 1 | RING, socket mounting |
| -27 | 136-0015-00 | | | 4 | SOCKET, tube, 9 pin |
| | - - - - - - | | | - | mounting hardware for each: (not included w/socket) |
| -28 | 213-0044-00 | | | 2 | SCREW, thread forming, 5-32 x 3/16 inch PHS |
| -29 | 670-0652-00 | | | 1 | ASSEMBLY, circuit board—Band Pass Filter |
| | - - - - - - | | | - | assembly includes: |
| | 388-0904-00 | | | 1 | BOARD, circuit |
| -30 | 131-0633-00 | | | 9 | TERMINAL, pin |
| | - - - - - - | | | - | mounting hardware: (not included w/assembly) |
| -31 | 385-0080-00 | | | 2 | ROD, hex., 6-32 x 7/16 inch long |
| -32 | 211-0116-00 | | | 2 | SCREW, sems, 4-40 x 5/16 inch, PHB |
| -33 | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch, PHS |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| -34 | 441-0864-00 | | | 1 | CHASSIS, horizontal |
| | - - - - - - | | | - | mounting hardware: (not included w/chassis) |
| | 212-0004-00 | | | 5 | SCREW, 8-32 x 5/16 inch, PHS |
| -35 | 212-0070-00 | | | 5 | SCREW, 8-32 x 5/16 inch, FHS |
| | 210-0458-00 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| -36 | - - - - - - | | | 3 | CAPACITOR |
| | - - - - - - | | | - | mounting hardware for each: (not included w/capacitor) |
| -37 | 432-0048-00 | | | 1 | BASE, capacitor mounting |
| -38 | 386-0254-00 | | | 1 | PLATE, fiber, large |
| -39 | 211-0588-00 | | | 2 | SCREW, 6-32 x 3/4 inch, HHS |
| -40 | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| -41 | 200-0260-00 | | | 2 | COVER, capacitor, plastic, 1.365 ID x 2 1/32 inches long |
| -42 | 200-0538-00 | | | 1 | COVER, capacitor, plastic, 1.365 ID x 1.644 inches long |
| -43 | - - - - - - | | | 1 | TRANSFORMER |
| | - - - - - - | | | - | transformer includes: |
| -44 | 212-0515-00 | | | 4 | SCREW, 10-32 x 2 1/4 inches, HHS |
| | 210-0812-00 | | | 4 | WASHER, fiber, #10 |
| | - - - - - - | | | - | mounting hardware not included w/transformer |
| -45 | 220-0410-00 | | | 4 | NUT, keps, 10-32 x 3/8 inch |

## FIG. 2 CHASSIS *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description 1 2 3 4 5 |
|---|---|---|---|---|---|
| 2-46 | 129-0006-00 | | | 4 | POST, connecting, insulated |
| -47 | - - - - - - | | | 1 | CAPACITOR |
| | - - - - - - | | | - | mounting hardware: (not included w/capacitor) |
| -48 | 210-0261-00 | | | 2 | LUG, solder |
| -49 | 211-0587-00 | | | 1 | SCREW, 6-32 x 3/16 inch, HHS |
| -50 | 210-0935-00 | | | 2 | WASHER, fiber, 0.140 ID x 0.375 inch OD |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, PHS |
| -51 | 348-0031-00 | | | 5 | GROMMENT, plastic, 1/8 inch diameter |
| -52 | 131-0513-03 | | | 74 | TERMINAL, feed through, 0.89 inch long |
| | - - - - - - | | | - | mounting hardware for each: (not included w/terminal) |
| | 358-0329-00 | | | 1 | BUSHING, feed through |
| -53 | 131-0153-02 | | | 10 | TERMINAL, feed through, 0.83 inch long |
| | - - - - - - | | | - | mounting hardware for each: (not included w/terminal) |
| | 358-0329-00 | | | 1 | BUSHING, feed through |
| -54 | 214-1196-00 | | | 1 | SHIELD, plastic, circuit board |
| -55 | 670-0620-00 | | | 1 | ASSEMBLY, circuit board—Low Voltage Power Supply |
| | - - - - - - | | | - | assembly includes: |
| | 388-1148-00 | | | 1 | BOARD, circuit |
| -56 | 136-0220-00 | | | 5 | SOCKET, transistor, 3 pin |
| -57 | 136-0183-00 | | | 2 | SOCKET, transistor, 3 pin |
| -58 | 136-0263-01 | | | 25 | SOCKET, terminal pin |
| -59 | 344-0154-00 | | | 6 | CLIP, fuse holder |
| | - - - - - - | | | - | mounting hardware: (not included w/assembly) |
| | 344-0147-00 | | | 2 | CLIP, circuit board |
| | 214-0966-00 | | | 2 | SPRING, helical |
| | 214-0967-02 | | | 2 | PIN, guide |
| | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 220-0543-00 | | | 2 | NUT, hex., 5-40 x 0.25 inch, self-locking |
| -60 | 670-0618-00 | 101 | 11569 | 1 | ASSEMBLY, circuit board—SWEEP GEN/HORIZ. AMP |
| | 670-0618-01 | 11570 | 12279 | 1 | ASSEMBLY, circuit board—SWEEP GEN/HORIZ. AMP |
| | 670-0618-02 | 12280 | 14099 | 1 | ASSEMBLY, circuit board—SWEEP GEN/HORIZ. AMP |
| | 670-0618-03 | 14100 | | 1 | ASSEMBLY, circuit board—SWEEP GEN/HORIZ. AMP |
| | - - - - - - | | | - | assembly includes: |
| | 388-1146-00 | | | 1 | BOARD, circuit |
| -61 | 136-0183-00 | | | 3 | SOCKET, transistor, 3 pin |
| -62 | 136-0220-00 | | | 18 | SOCKET, transistor, 3 pin |
| -63 | 214-0579-00 | | | 11 | PIN, test point |
| -64 | - - - - - - | | | 2 | TRANSISTOR |
| | - - - - - - | | | - | mounting hardware for each: (not included w/transistor) |
| | 211-0511-00 | | | 2 | SCREW, 6-32 x 1/2 inch, PHS |
| -65 | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0261-00 | X12280 | | 1 | LUG, solder |
| | 210-0006-00 | X12720 | | 3 | LOCKWASHER, internal, #6 |
| | 136-0234-00 | | | 2 | RECEPTABLE, electrical |

## FIG. 2 CHASSIS *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description 1 2 3 4 5 |
|---|---|---|---|---|---|
| 2-66 | 136-0263-01 | | | 49 | SOCKET, terminal pin (for 0.025 inch pin) |
| | 136-0252-01 | | | 8 | SOCKET, terminal pin (for 0.019 inch pin) |
| -67 | 131-0589-00 | | | 2 | TERMINAL |
| | - - - - - - | | | - | mounting hardware: (not included w/assembly) |
| -68 | 344-0147-00 | | | 3 | CLIP, circuit board |
| -69 | 214-0966-00 | | | 3 | SPRING, helical |
| -70 | 214-0967-02 | | | 3 | PIN, guide |
| -71 | 210-0457-00 | | | 3 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0006-00 | | | 3 | LOCKWASHER, internal #6 |
| -72 | 220-0543-00 | | | 3 | NUT, hex., 5-40 x 0.25 inch, self-locking |
| -73 | 670-0647-00 | | | 1 | ASSEMBLY, circuit board—High Voltage |
| | - - - - - - | | | - | assembly includes: |
| | 388-1183-00 | | | 1 | BOARD, circuit |
| -74 | 388-1200-00 | | | 1 | BOARD, circuit, shield |
| -75 | 136-0183-00 | | | 2 | SOCKET, transistor, 3 pin |
| -76 | 136-0228-00 | | | 1 | SOCKET, tube, 9 pin |
| -77 | 352-0066-00 | | | 2 | HOLDER, capacitor |
| | - - - - - - | | | - | mounting hardware for each: (not included w/holder) |
| -78 | 361-0008-00 | | | 2 | SPACER, plastic, 0.281 inch long |
| -79 | 136-0263-01 | | | 11 | SOCKET, terminal pin |
| -80 | 352-0086-00 | | | 1 | HOLDER, toroid |
| -81 | 337-1154-00 | | | 1 | SHIELD, plastic |
| -82 | 343-0216-00 | | | 1 | RETAINER, High Voltage transformer |
| -83 | 361-0137-00 | 101 | 12449 | 2 | SPACER, plastic, 1/4 x 1.345 inches long |
| | 361-0137-01 | 12450 | | 2 | SPACER, plastic, 1/4 x 1.345 inches long |
| -84 | 211-0036-00 | | | 2 | SCREW, 4-40 x 1/2 inch, BH plastic |
| -85 | 211-0097-00 | | | 2 | SCREW, 4-40 x 5/16 inch, BHS |
| -86 | 131-0633-00 | | | 10 | TERMINAL, pin |
| -87 | 385-0097-00 | | | 3 | ROD, plastic, 5/16 x 2 inches long |
| -88 | 129-0214-00 | | | 3 | POST, plastic, 0.25 x 0.20 inch long |
| -89 | 211-0511-00 | | | 3 | SCREW, 6-32 x 1/2 inch, PHS |
| -90 | 337-0649-00 | | | 1 | SHIELD, tube, heat dissipating |
| | - - - - - - | | | - | mounting hardware: (not included w/assembly) |
| -91 | 344-0147-00 | | | 4 | CLIP, circuit board |
| -92 | 214-0966-00 | | | 3 | SPRING, helical |
| -93 | 214-0967-02 | | | 3 | PIN, guide |
| | 210-0457-00 | | | 3 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0006-00 | | | 3 | LOCKWASHER, internal #6 |
| -94 | 129-0222-00 | | | 1 | POST, plastic |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, PHS |
| -95 | 220-0543-00 | | | 3 | NUT, hex., 5-40 x 0.25 inch, self-locking |
| -96 | 337-1138-00 | | | 1 | SHIELD, plexiglass |
| | - - - - - - | | | - | mounting hardware: (not included w/shield) |
| -97 | 211-0507-00 | | | 3 | SCREW, 6-32 x 5/16 inch, PHS |
| -98 | 210-0869-00 | | | 6 | WASHER, plastic, 5/32 ID x 3/8 inch OD |
| | - - - - - - | | | - | mounting hardware for each: (not included w/washer) |
| -99 | 211-0097-00 | | | 1 | SCREW, 4-40 x 5/16 inch, PHS |
| | 210-0586-00 | | | 1 | NUT, keps, 4-40 x 1/4 inch |
| -100 | 105-0065-00 | | | 6 | SUPPORT, plastic |
| | - - - - - - | | | - | mounting hardware for each: (not included w/support) |
| | 361-0007-00 | | | 1 | SPACER, plastic, 0.188 inch long |

## FIG. 2 CHASSIS *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 2-102 | 200-0616-00 | | | 1 | | COVER, CRT socket |
| -103 | 179-1363-00 | 101 | 11189 | 1 | | CABLE HARNESS, CRT |
| | - - - - - - | | | - | | cable harness includes: |
| -104 | 136-0216-02 | 11190 | | 1 | | SOCKET, CRT |
| -105 | 124-0100-00 | | | 1 | | STRIP, ceramic, 7/16 inch h, w/1 notch |
| | - - - - - - | | | - | | strip includes: |
| | 355-0046-00 | | | 1 | | STUD, plastic |
| | - - - - - - | | | - | | mounting hardware: (not included w/strip) |
| | 361-0007-00 | | | 1 | | SPACER, plastic, 0.188 inch long |
| -106 | 124-0146-00 | | | 2 | | STRIP, ceramic, 7/16 inch h, w/16 notches |
| | - - - - - - | | | - | | each strip includes: |
| | 355-0046-00 | | | 2 | | STUD, plastic |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/strip) |
| | 361-0009-00 | | | 2 | | SPACER, plastic, 0.406 inch long |
| -107 | 124-0145-00 | | | 8 | | STRIP, ceramic, 7/16 inch h, w/20 notches |
| | - - - - - - | | | - | | each strip includes: |
| | 355-0046-00 | | | 2 | | STUD, plastic |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/strip) |
| | 361-0009-00 | | | 2 | | SPACER, plastic, 0.406 inch long |
| -108 | 124-0147-00 | | | 2 | | STRIP, ceramic, 7/16 inch h, w/13 notches |
| | - - - - - - | | | - | | each strip includes: |
| | 355-0046-00 | | | 2 | | STUD, plastic |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/strip) |
| | 361-0009-00 | | | 2 | | SPACER, plastic, 0.406 inch long |

## FIG. 3 CRT & REAR

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 3-1 | 124-0167-00 | | | 1 | | STRIP, CRT shield, rubber |
| -2 | 136-0112-00 | | | 2 | | SOCKET, graticule lamp |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/socket) |
| -3 | 211-0534-00 | | | 1 | | SCREW, sems, 6-32 x 5/16 inch, PHS |
| -4 | 210-0803-00 | | | 1 | | WASHER, flat, 0.150 ID x 3/8 inch OD |
| -5 | 210-0457-00 | | | 1 | | NUT, keps, 6-32 x 5/16 inch |
| -6 | 337-0725-00 | | | 1 | | SHIELD, CRT |
| | - - - - - - | | | - | | mounting hardware: (not included w/shield) |
| -7 | 211-0534-00 | | | 8 | | SCREW, sems, 6-32 x 5/16 inch, PHS |
| | 210-0457-00 | | | 8 | | NUT, keps, 6-32 x 5/16 inch |
| -8 | 348-0056-00 | | | 2 | | GROMMET, plastic, 3/8 inch diameter |
| -9 | 175-0585-00 | | | 1 | | WIRE, CRT lead, striped brown |
| | 175-0588-00 | | | 1 | | WIRE, CRT lead, striped orange |
| | 175-0592-00 | | | 1 | | WIRE, CRT lead, striped green |
| | 175-0593-00 | | | 1 | | WIRE, CRT lead, striped blue |
| | 175-0595-00 | | | 1 | | WIRE, CRT lead, striped red |
| | - - - - - - | | | - | | each wire includes: |
| -10 | 131-0049-00 | | | 1 | | CONNECTOR, CRT cable, female |
| -11 | 352-0044-00 | | | 1 | | HOLDER, coil form |
| | - - - - - - | | | - | | mounting hardware: (not included w/holder) |
| | 211-0097-00 | | | 1 | | SCREW, 4-40 x 5/16 inch, PHS |
| -12 | 210-0004-00 | | | 1 | | LOCKWASHER, internal, #4 |
| -13 | 210-0406-00 | | | 1 | | NUT, hex., 4-40 x 3/16 inch |
| -14 | 406-0730-00 | | | 1 | | BRACKET, parallax adjustment |
| | - - - - - - | | | - | | mounting hardware: (not included w/bracket) |
| -15 | 211-0534-00 | | | 4 | | SCREW, sems, 6-32 x 5/16 inch, PHS |
| -16 | 210-0457-00 | | | 4 | | NUT, keps, 6-32 x 5/16 inch |
| -17 | 211-0576-00 | | | 2 | | SCREW, 6-32 x 7/8 inch, socket head cap |
| -18 | 210-0949-00 | | | 2 | | WASHER, flat, 9/64 ID x 1/2 inch OD |
| -19 | 354-0249-00 | | | 1 | | RING, CRT clamping |
| | - - - - - - | | | - | | ring includes: |
| -20 | 124-0171-00 | | | 1 | | STRIP, liner, CRT clamp |
| -21 | 211-0560-00 | | | 1 | | SCREW, 6-32 x 1 inch, RHS |
| -22 | 220-0419-00 | | | 1 | | NUT, square, 6-32 x 5/16 inch |
| -23 | 214-0207-00 | | | 1 | | NUT, adjustment securing |
| -24 | 214-0210-00 | | | 1 | | ASSEMBLY, solder spool |
| | - - - - - - | | | - | | assembly includes: |
| | 214-0209-00 | | | 1 | | SPOOL, w/o solder |
| | - - - - - - | | | - | | mounting hardware: (not included w/assembly) |
| -25 | 361-0007-00 | | | 1 | | SPACER, plastic, 0.188 inch long |

## FIG. 3 CRT & REAR *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty 1 2 3 4 5 | Description |
|---|---|---|---|---|---|
| 3-26 | 348-0002-00 | | | 1 | GROMMET, rubber, 1/4 inch diameter |
| -27 | 131-0126-00 | | | 5 | CONNECTOR, coaxial, 1 contact, BNC, female, w/hardware |
| -28 | 131-0279-00 | 9500 | 10697 | 4 | CONNECTOR, BNC, female |
| | 131-0274-00 | 10698 | | 4 | CONNECTOR, BNC |
| | - - - - - - | | | - | mounting hardware for each: (not included w/connector) |
| -29 | 211-0025-00 | 9500 | 10697X | 2 | SCREW, 4-40 x 3/8 inch, 100° csk, FHS |
| -30 | 406-0244-00 | 9500 | 10697X | 1 | BRACKET, plastic |
| -31 | 210-0224-00 | | | 1 | LUG, solder, #10 |
| -32 | 210-0812-00 | | | 2 | WASHER, fiber, #10 |
| -33 | 210-0004-00 | | | 2 | LOCKWASHER, internal, #4 |
| -34 | 210-0406-00 | | | 2 | NUT, hex., 4-40 x 3/16 inch |
| -35 | 136-0089-00 | | | 1 | SOCKET, 9 pin, w/female insert |
| | - - - - - - | | | - | mounting hardware: (not included w/socket) |
| -36 | 211-0097-00 | | | 4 | SCREW, 4-40 x 5/16 inch, PHS |
| -37 | 210-0004-00 | | | 3 | LOCKWASHER, internal, #4 |
| -38 | 210-0201-00 | | | 1 | LUG, solder, SE #4 |
| -39 | 210-0406-00 | | | 4 | NUT, hex., 4-40 x 3/16 inch |
| 40 | - - - - - - | | | 3 | TRANSISTOR |
| | - - - - - - | | | - | mounting hardware for each: (not included w/transistor) |
| 41- | 211-0504-00 | | | 2 | SCREW, 6-32 x 1/4 inch, PHS |
| -42 | 214-1129-00 | 9500 | 10199 | 1 | HEAT SINK |
| | 214-1129-02 | 10200 | | 1 | HEAT SINK |
| | - - - - - - | | | - | mounting hardware: (not included w/heat sink) |
| -43 | 212-0010-00 | | | 4 | SCREW, 8-32 x 5/8 inch, PHS |
| -44 | 210-0206-00 | 101 | 12219 | 1 | LUG, solder, SE #10, long |
| | 129-0006-00 | 12220 | | 1 | POST, connecting |
| | - - - - - - | | | - | mounting hardware: (not included w/lug or post) |
| -45 | 212-0004-00 | 101 | 12219 | 1 | SCREW, 8-32 x 5/16 inch, PHS |
| | 210-0202-00 | 12220 | | 1 | LUG, solder, SE #6 |
| -46 | 210-0458-00 | 101 | 12219 | 1 | NUT, keps, 8-32 x 11/32 inch |
| | 210-0457-00 | 12220 | | 1 | NUT, keps, 6-32 x 0.312 inch |
| | 200-0237-00 | X12220 | | 1 | COVER, fuse holder, plastic |
| | 352-0002-00 | | | 1 | ASSEMBLY, fuse holder |
| | - - - - - - | | | - | assembly includes: |
| -47 | 200-0582-00 | | | 1 | CAP, fuse, black |
| -48 | 352-0010-00 | | | 1 | HOLDER, fuse |
| -49 | 210-0873-00 | | | 1 | WASHER, rubber, 1/2 ID x 11/16 inch OD |
| -50 | - - - - - - | | | 1 | NUT |
| -51 | 334-1366-00 | | | 1 | PLATE, instruction |
| | - - - - - - | | | - | mounting hardware: (not included w/plate) |
| -52 | 213-0088-00 | | | 2 | SCREW, thread forming, #4 x 1/4 inch, PHS |



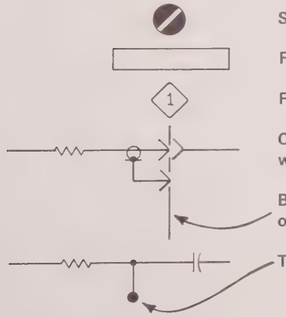
©

## FIG. 3 CRT & REAR *(cont)*

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | 1 2 3 4 5 | Description |
|---|---|---|---|---|---|---|
| 3-53 | 358-0025-00 | | | 1 | | BUSHING, strain relief |
| -54 | 161-0017-00 | | | 1 | | CORD, power |
| -55 | 386-1406-00 | 9500 | 10697 | 1 | | PANEL, rear |
| | 386-1406-01 | 10698 | | 1 | | PANEL, rear |
| -56 | 386-0111-00 | 9500 | 11909 | 1 | | PLATE, side, right |
| | 386-0111-01 | 11910 | | 1 | | PLATE, side, right |
| | - - - - - - | | | - | | mounting hardware: (not included w/plate) |
| -57 | 212-0070-00 | | | 4 | | SCREW, 8-32 x 5/16 inch, 100° csk, FHS |
| -58 | 210-0458-00 | | | 4 | | NUT, keps, 8-32 x 11/32 inch |
| -59 | 386-0109-00 | 9500 | 11909 | 1 | | PLATE, side, left |
| | 386-0109-01 | 11910 | | 1 | | PLATE, side, left |
| | - - - - - - | | | - | | mounting hardware: (not included w/plate) |
| -60 | 212-0070-00 | | | 4 | | SCREW, 8-32 x 5/16 inch, 100° csk, FHS |
| -61 | 210-0458-00 | | | 4 | | NUT, keps, 8-32 x 11/32 inch |
| -62 | 390-0093-00 | 9500 | 11819 | 1 | | CABINET TOP |
| | 390-0093-01 | 11820 | | 1 | | CABINET TOP |
| | - - - - - - | | | - | | mounting hardware: (not included w/cabinet top) |
| -63 | 211-0504-00 | | | 1 | | SCREW, 6-32 x 1/4 inch, PHS |
| -64 | 390-0094-00 | 9500 | 11819 | 1 | | CABINET BOTTOM |
| | 390-0094-01 | 11820 | | 1 | | CABINET BOTTOM |
| | - - - - - - | | | - | | mounting hardware: (not included w/cabinet bottom) |
| -65 | 211-0504-00 | | | 6 | | SCREW, 6-32 x 1/4 inch, PHS |
| -66 | 351-0040-01 | | | 1 PR | | TRACK, guide, left and right, w/hardware |
| | - - - - - - | | | - | | mounting hardware for each: (not included w/track) |
| -67 | 212-0004-00 | | | 1 | | SCREW, 8-32 x 5/16 inch, PHS |

# SECTION 8
# DIAGRAMS

The following symbols are used on the diagrams:



Screwdriver adjustment

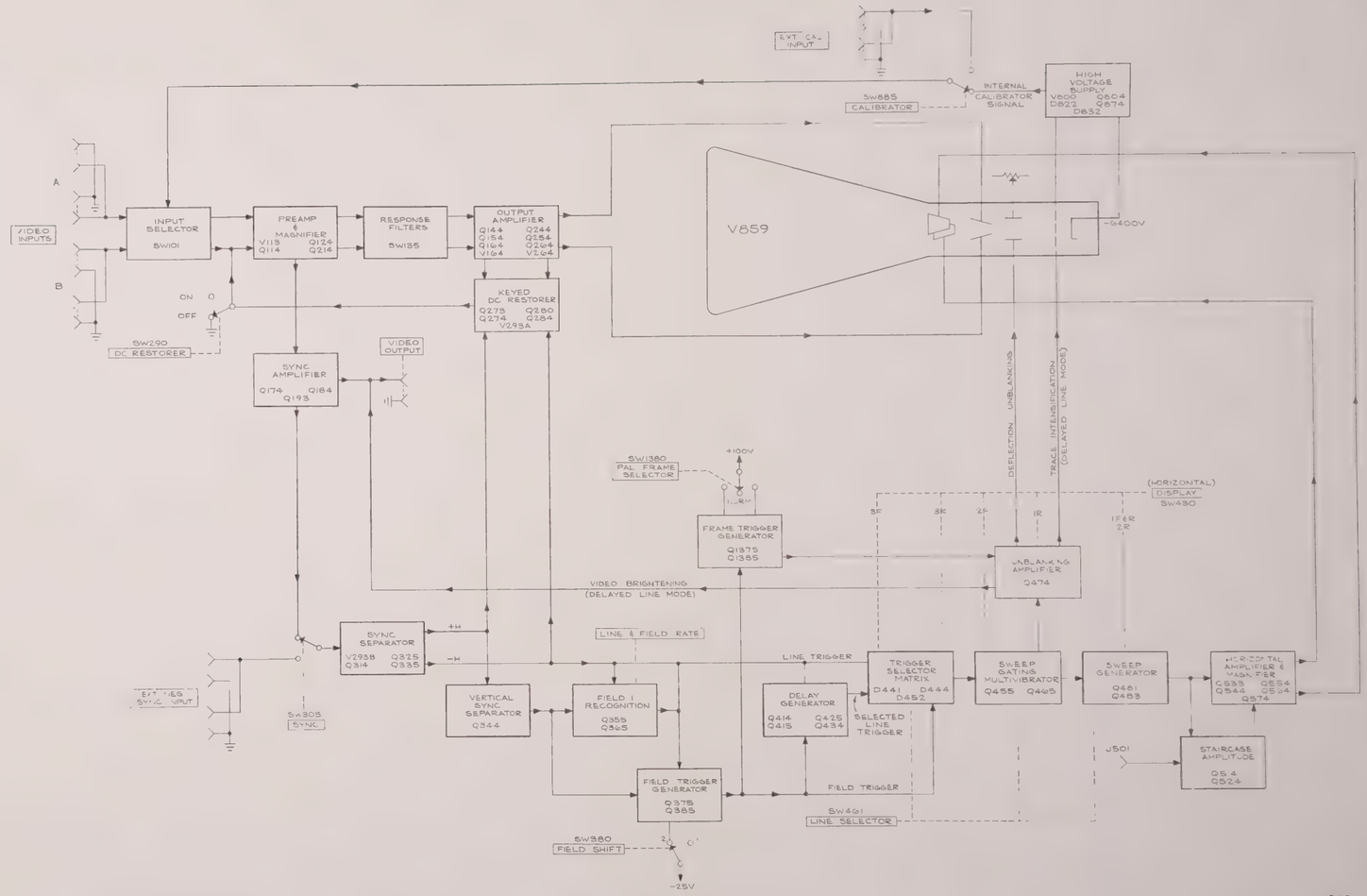
Front or rear panel control or connector

Refer to indicated diagram

Connection to circuit board made with pin connector at indicated pin

Blue lines enclosed components located on circuit board

Test point

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Ⓐ

BLOCK DIAGRAM

## IMPORTANT

## VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages measured with a 20,000 Ω/volt VOM. All readings in volts. Voltages are measured with respect to chassis ground unless otherwise noted.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule.

Voltages and waveforms on the schematics (shown in blue) are not absolute and may vary between instruments.

The test oscilloscope used had the following characteristics: Minimum deflection factor, 0.02 volts/division using a 10X probe; frequency response, dc to 30 MHz; sweep rates, 5 ms to 20 μs; sweep magnification, X1, X20 and X100. AC input coupling was used.

To indicate true time relationship between signals and to obtain stable displays, the test oscilloscope was externally triggered through X1 probe from:

1. Collector of Q325 (−H signal) for all waveforms except those at the junction of C198 and R198, C364 and R365, C416 and the Collector of Q415.

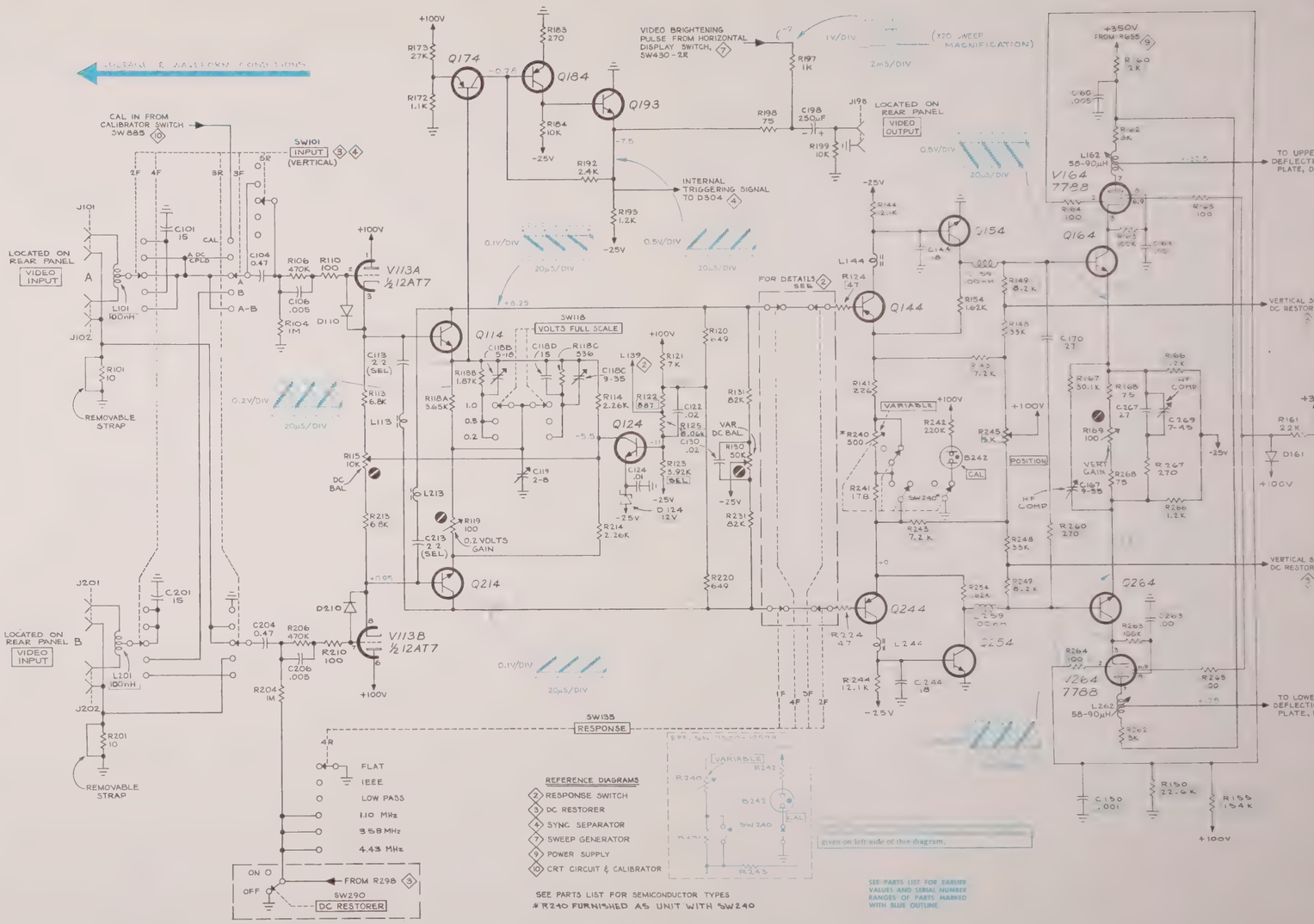
2. Collector of Q344 for waveforms at the junctions of C198 and R198, C364 and R365, C416 and the collector of Q415.

Voltage readings and waveforms were obtained using the following control settings, unless otherwise noted on the individual diagrams.

For waveforms, 1-volt of modulated staircase was connected to one VIDEO INPUTS A connector. The other VIDEO INPUTS A connector was terminated into 75 ohms.

For voltage readings, no input signal or termination was connected to the instrument.

| | |
|---|---|
| POWER | ON |
| SCALE ILLUM | 2/3 clockwise |
| FOCUS | Midrange |
| INTENSITY | Adjusted for normal display brightness |
| TRACE ROTATION | As is |
| **VERTICAL Controls** | |
| RESPONSE | FLAT |
| DC RESTORER | ON |
| INPUT | A AC COUPLED |
| VOLTS FULL SCALE | 1.0 |
| VARIABLE (VOLTS FULL SCALE) | CALIB |
| CALIBRATOR | .714 F.S. |
| POSITION | Midrange |
| GAIN | As is |
| **HORIZONTAL Controls** | |
| POSITION | Midrange |
| SYNC | INT |
| MAGNIFIER | X1 |
| VARIABLE (MAGNIFIER) | CALIB |
| DISPLAY | 10 μs/cm |
| LINE & FIELD RATE | 525/60 |
| LINE SELECTOR (SWITCH) | Variable |
| VARIABLE (LINE SELECTOR) | Fully clockwise |
| FIELD | TWO ODD |
| PAL FRAME SELECTOR | NORM |

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0371

VERTICAL AMPLIFIER 1

SW135
RESPONSE

5R 5R 1F 4F 3F 2F

TO WAFERS 1R-2R-3R-4R

| | | | |
|---|---|---|---|
| FLAT | | C131 0.1 | |
| IRE | O | | O |
| LOW PASS | O | | O |
| 1.10 MHz | ||--O | O |
| 3.5 MHz | ||--O | O |
| 4.43 MHz | ||--O | O → TO R204 ◇1 |

SWITCH GROUNDED IN CLOSED CONTACTS ONLY

FROM COLLECTOR Q114 ◇1

TO BASE Q244 ◇1

C136 53
L37 72μH
L133 60-120μH
L134 120-280μH
L135 120-280μH
C135 47C
L32 80μH
C132B 130
C138 5
R38 4
L138 23-64μH
L 33B 46μH
C140D 15
C140A 43
C140B 9-35
C140H 2-8
L36 280-470μH
L 34B 36μH
C140G 5.5-8
C140F 75
C133 39
C133 200
C139 9-35
C134 39C
L39 4μH
C139 9-35
C134 39C

FROM R125 ◇1

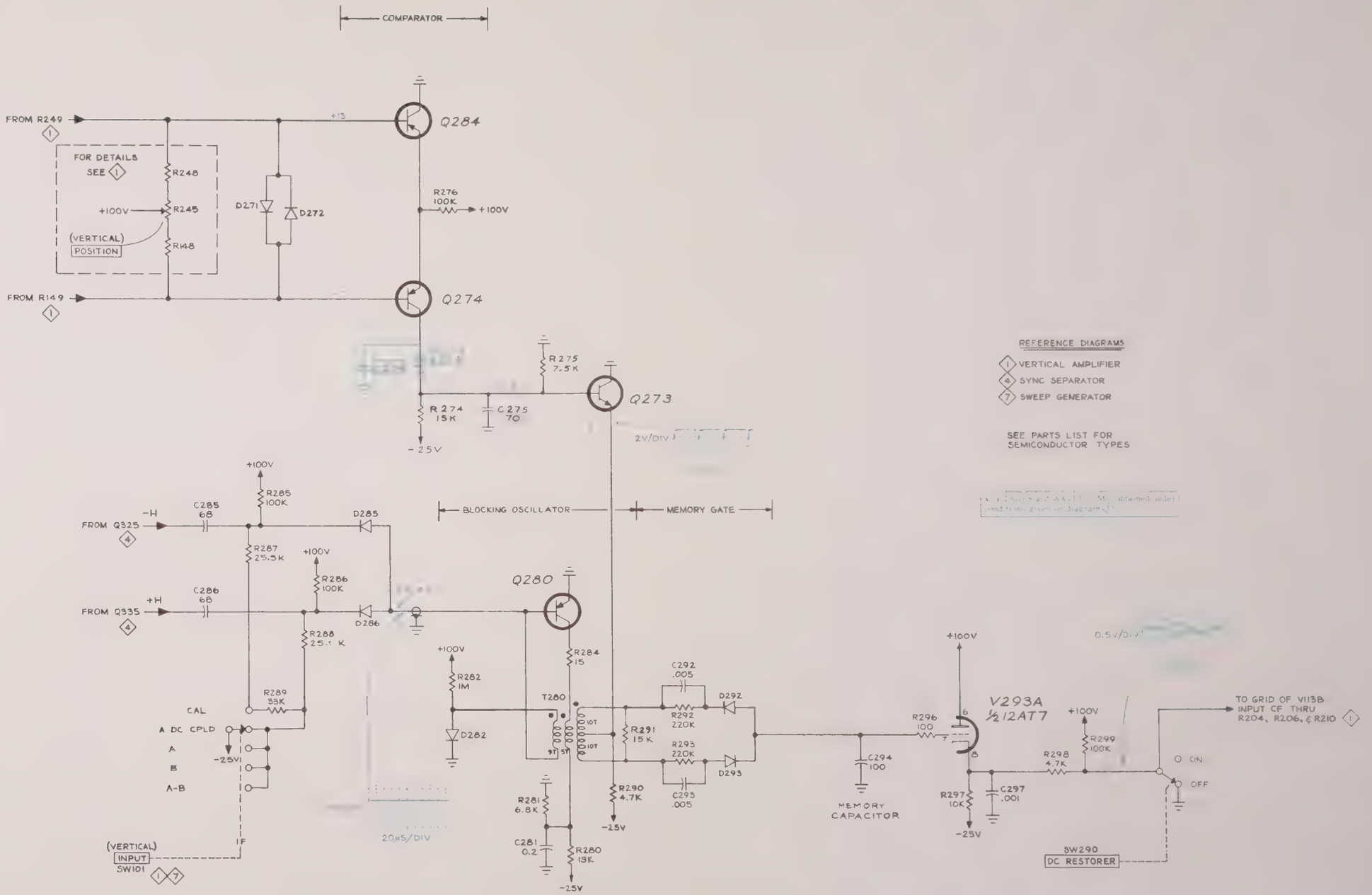
FROM COLLECTOR Q214 ◇1

TO BASE Q244 ◇1

C236 53
C235 47C
L233 60-120μH
L234 120-280μH
L235 20-280μH
L232 80μH
C232B 130
C238 51
R238 47
L238 23-64μH
L233B 46μH
C240D 15

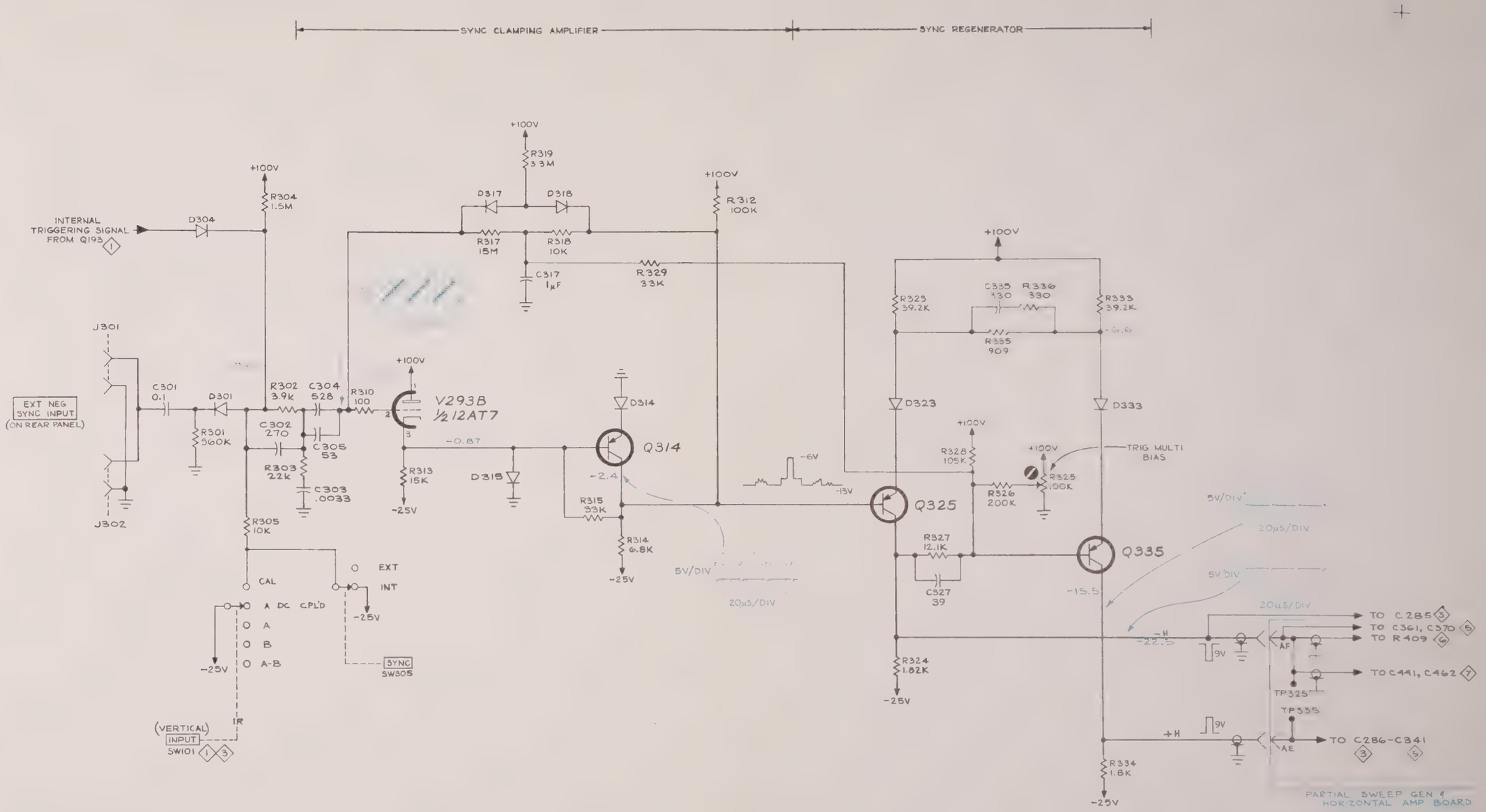
NOTE:
ALL INACTIVE FILTER NETWORKS ARE AC GROUNDED AT INPUT & OUTPUT THRU C131

REFERENCE DIAGRAMS
◇1 VERTICAL AMPLIFIER




1169

DC RESTORER 3

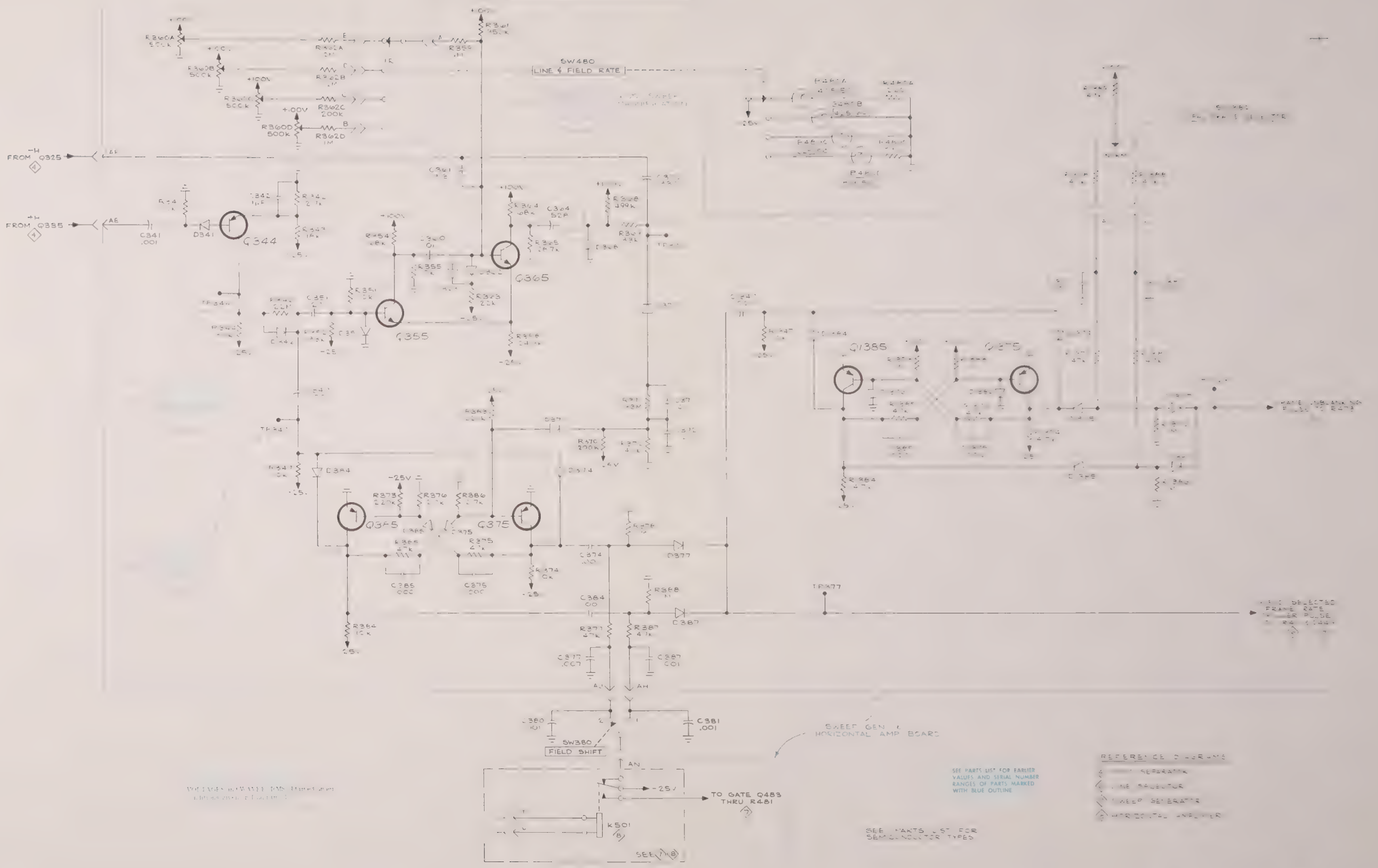



REFERENCE DIAGRAMS

- (1) VERTICAL AMPLIFIER
- (3) DC RESTORER
- (5) FIELD SELECTOR
- (6) LINE SELECTOR
- (7) SWEEP GENERATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES and WAVEFORMS obtained under conditions given on diagram (1).

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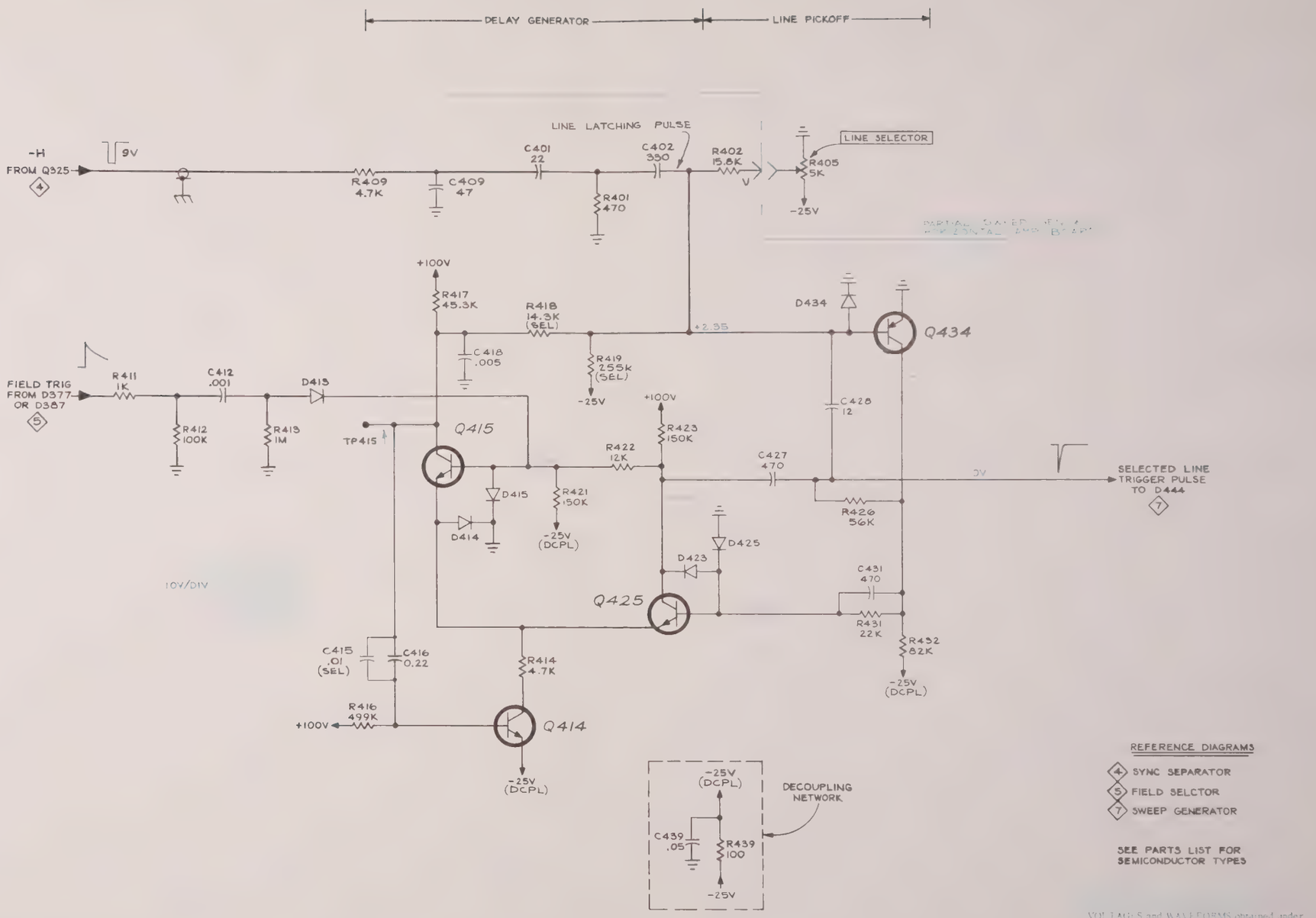
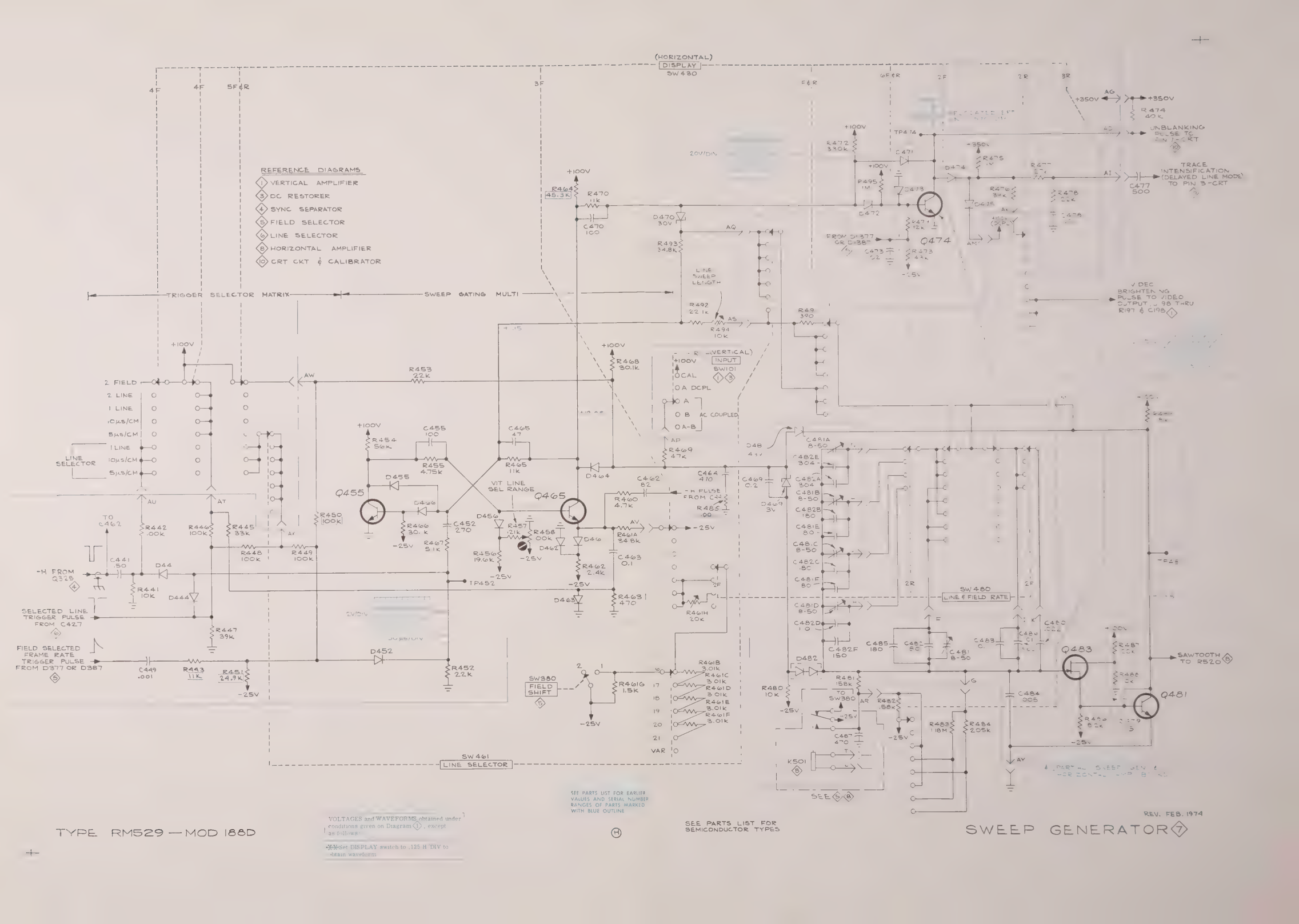
FIELD & FRAME SELECTOR (5)

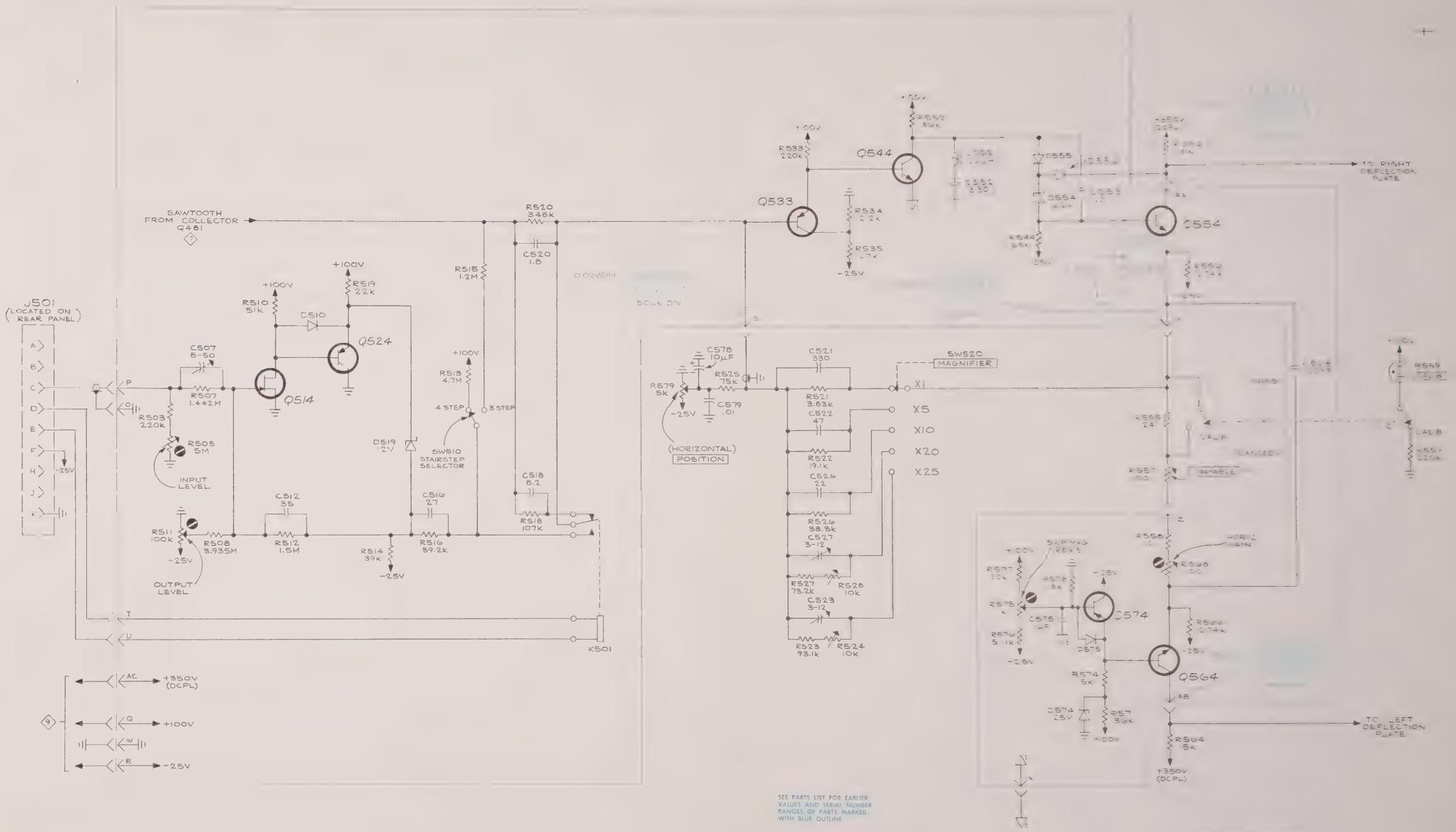

DELAY GENERATOR
LINE PICKOFF
LINE LATCHING PULSE
-H
FROM Q325
4
9V
R409
4.7K
C409
47
C401
22
C402
330
R401
470
R402
15.8K
LINE SELECTOR
R405
5K
-25V
+100V
R417
45.3K
R418
14.3K
(SEL)
+2.35
D434
Q434
C418
.005
R419
255K
(SEL)
-25V
FIELD TRIG
FROM D377
OR D387
5
R411
1K
C412
.001
D413
R412
100K
R413
1M
TP415
Q415
+100V
R423
150K
C428
12
R422
12K
C427
470
D415
R421
150K
D414
-25V
(DCPL)
D425
D423
C431
470
Q425
R431
22K
R432
82K
-25V
(DCPL)
R426
56K
3V
SELECTED LINE
TRIGGER PULSE
TO D444
7
C415
.01
(SEL)
C416
0.22
R414
4.7K
R416
499K
+100V
Q414
-25V
(DCPL)
-25V
(DCPL)
DECOUPLING
NETWORK
C439
.05
R439
100
-25V
REFERENCE DIAGRAMS
4 SYNC SEPARATOR
5 FIELD SELCTOR
7 SWEEP GENERATOR
SEE PARTS LIST FOR
SEMICONDUCTOR TYPES




TYPE RM529 — MOD 188D

SWEEP GENERATOR 7

REV. FEB. 1974

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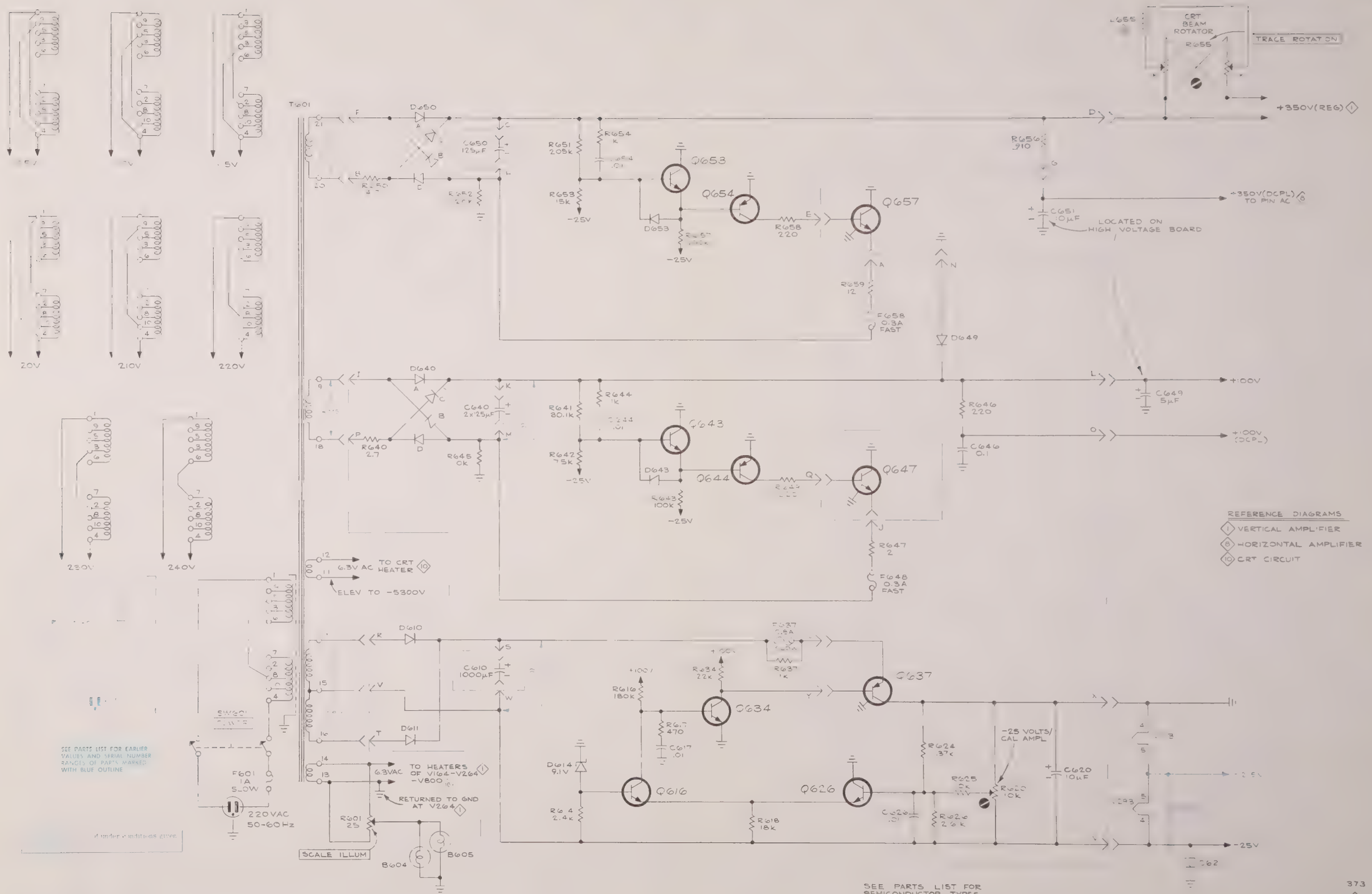
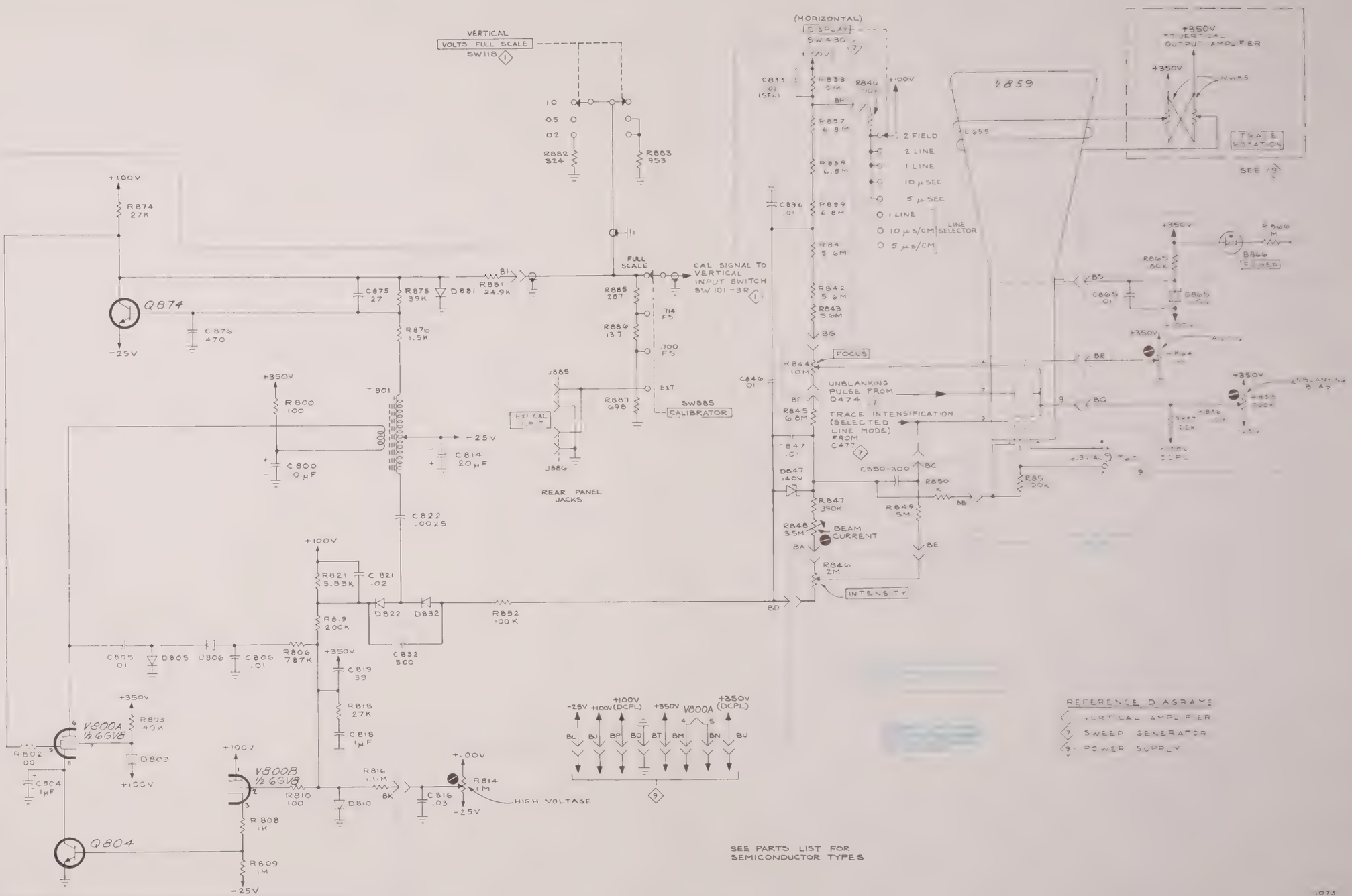
HORIZONTAL AMPLIFIER 8

3970


T601
D650
C650 125μF
R651 205k
R654 1k
.01
Q653
Q654
Q657
R653 15k
-25V
D653
R658 220
R659 12
F658 0.3A FAST
CRT BEAM ROTATOR
R655
TRACE ROTATION
L655
+350V(REG) 1
R656 910
+350V(DCPL) TO PIN AC 8
C651 10μF
LOCATED ON HIGH VOLTAGE BOARD
D649
D640
C640 2x25μF
R640 2.7
R645 0k
R641 80.1k
R644 1k
.01
Q643
Q644
Q647
R642 75k
D643
R643 100k
R646 220
C646 0.1
C649 5μF
+100V
+100V (DCPL)
F648 0.3A FAST
R647 2
REFERENCE DIAGRAMS
1 VERTICAL AMPLIFIER
8 HORIZONTAL AMPLIFIER
10 CRT CIRCUIT
6.3V AC TO CRT HEATER 10
ELEV TO -5300V
D610
C610 1000μF
D611
SW601
F601 1A SLOW
220VAC 50-60Hz
6.3VAC TO HEATERS OF V164-V264 1 -V800 10
RETURNED TO GND AT V264 1
R601 25
SCALE ILLUM
B604
B605
F637 0.5A
R637 1k
Q637
R634 22k
Q634
R616 180k
R617 470
C617 .01
D614 9.1V
R614 2.4k
Q616
Q626
R624 37k
R625 2k
R620 10k
-25 VOLTS/ CAL AMPL
C620 10μF
C626 .01
R626 2.6k
R618 18k
-25V
C662
20V
210V
220V
230V
240V
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE
SEE PARTS LIST FOR SEMICONDUCTOR TYPES




TYPE RM529 - MOD 188D

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CRT CIRCUIT & CALIBRATOR 10

FIG. 1 FRONT

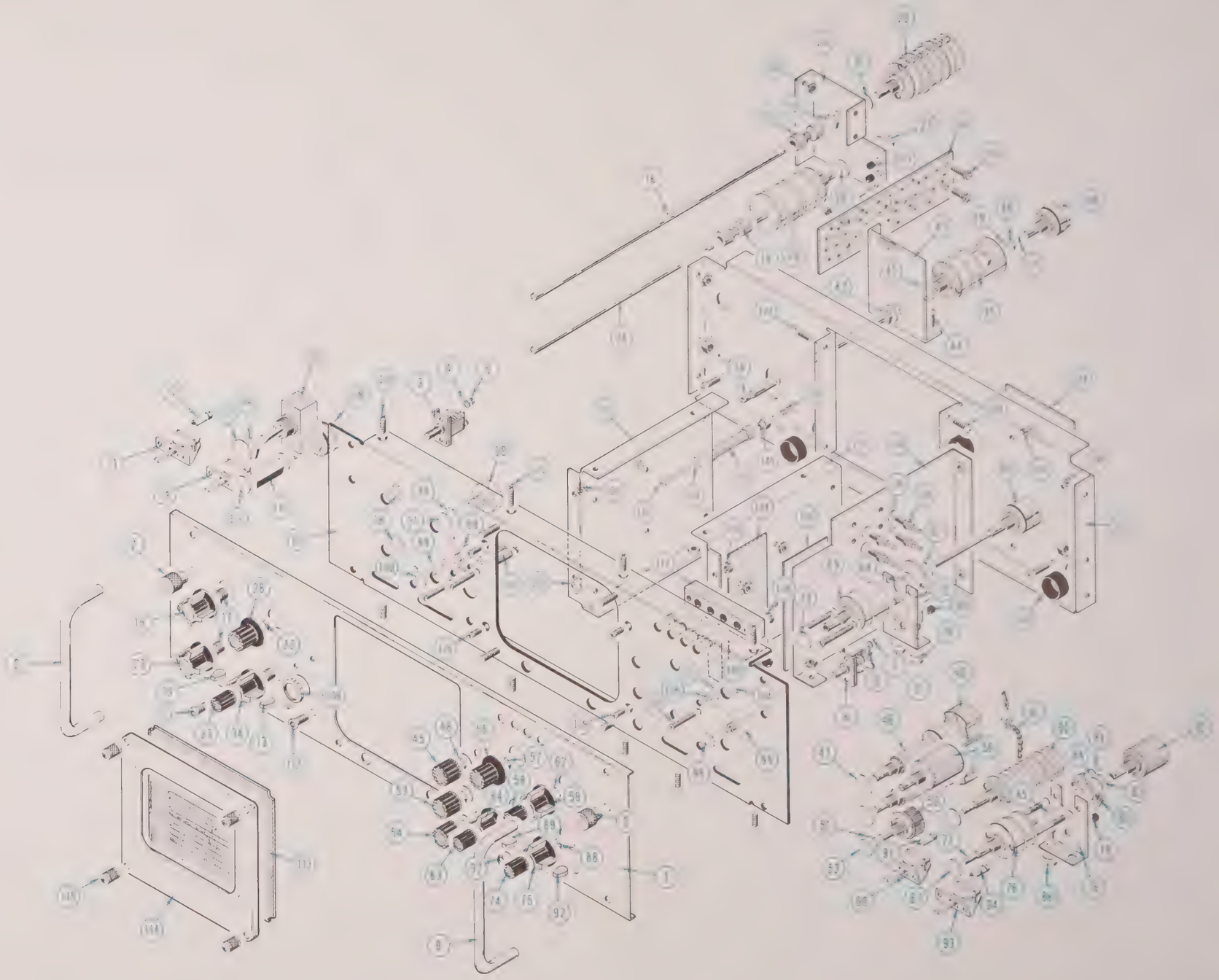


FIG. 2 CHASSIS

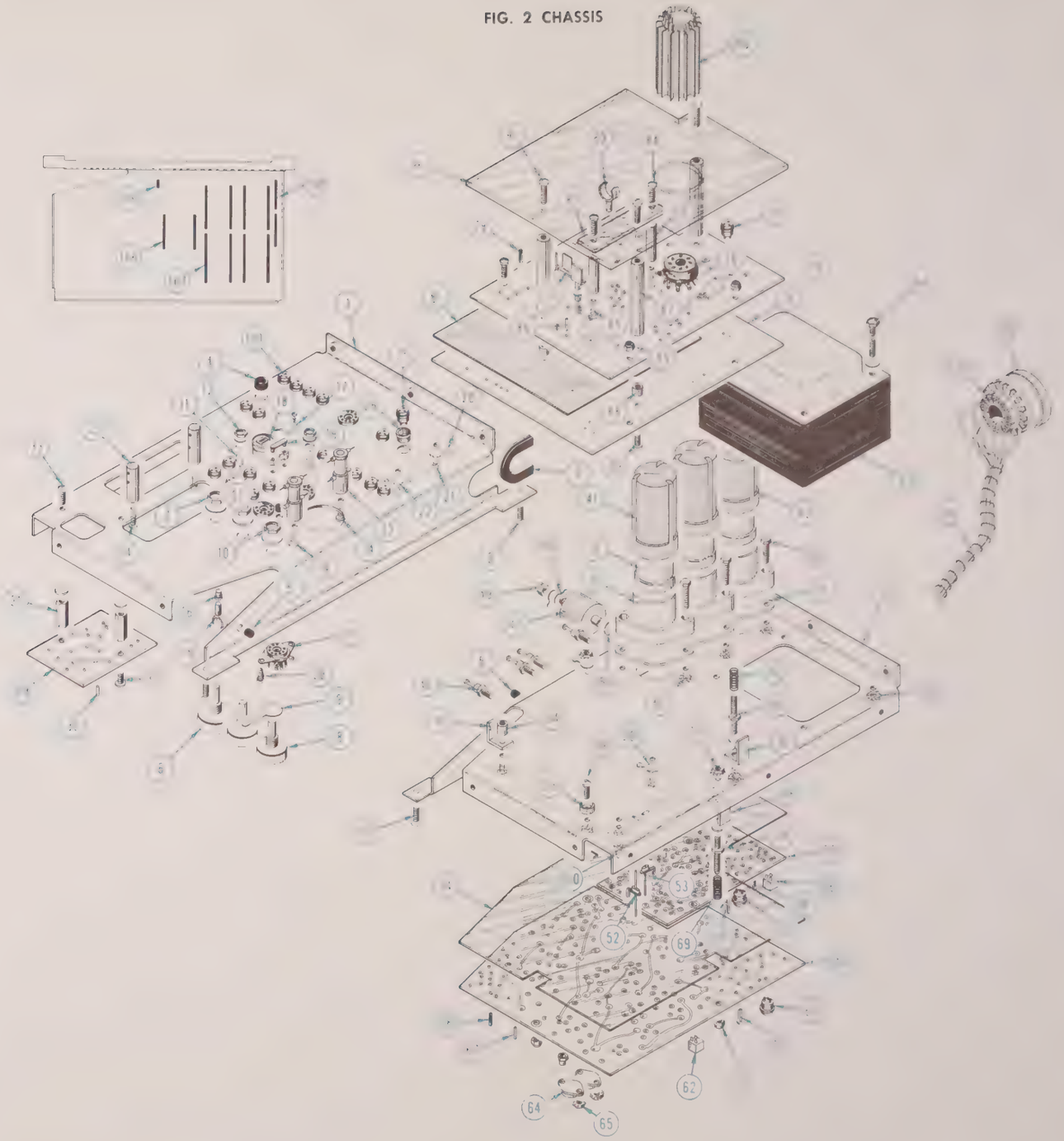
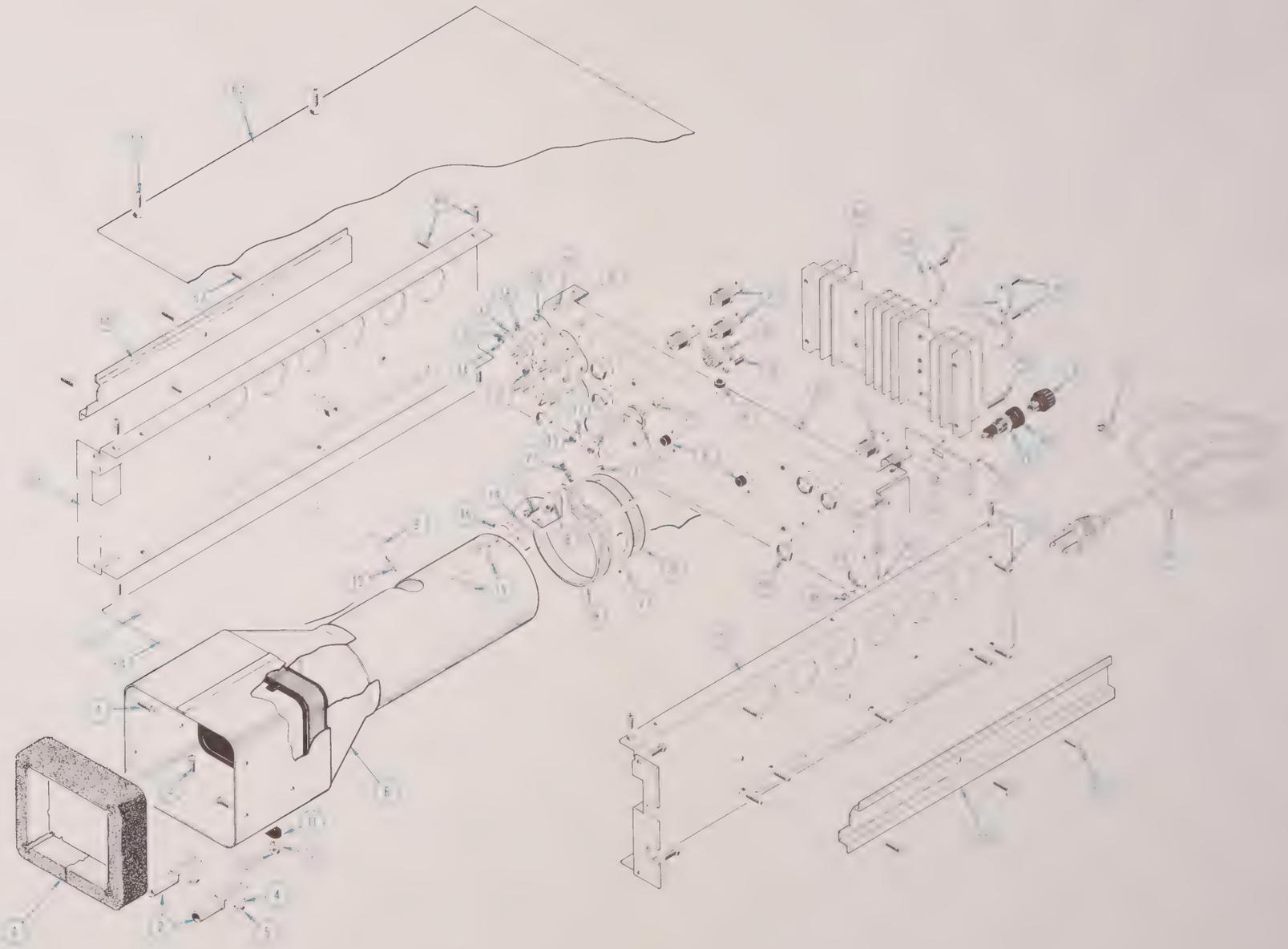


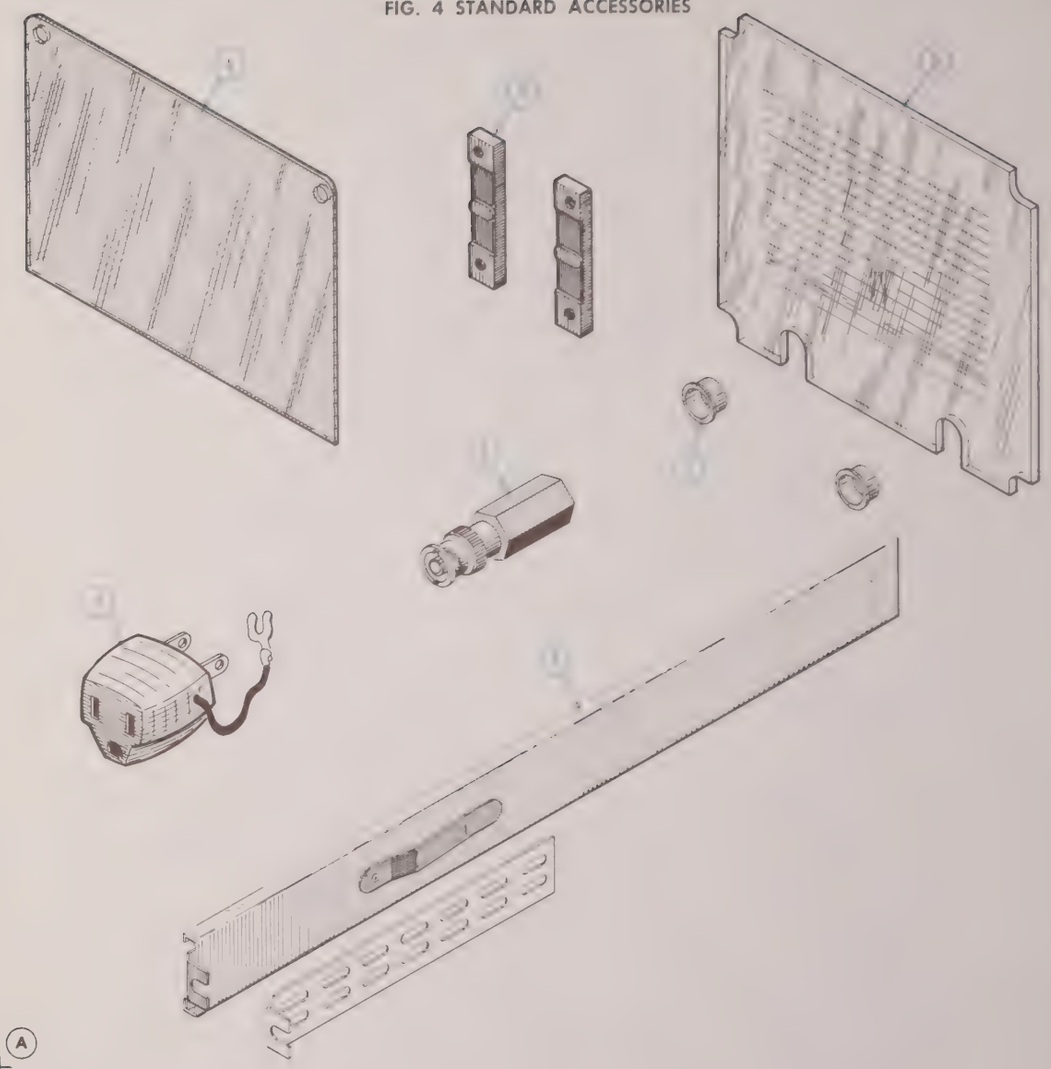
FIG. 3 CRT & REAR



## FIG. 4 STANDARD ACCESSORIES

| Fig. & Index No. | Tektronix Part No. | Serial/Model No. Eff | Serial/Model No. Disc | Qty | Description |
|---|---|---|---|---|---|
| 4-1 | 011-0102-00 | | | 1 | TERMINATION, coaxial, 75 Ω, 5 W, BNC |
| -2 | 103-0013-00 | | | 1 | ADAPTER, power cord, 3 to 2 wire |
| -3 | 331-0161-02 | 9500 | 11109 | 1 | GRATICULE, plexiglass |
| | 331-0161-06 | 11110 | | 1 | GRATICULE, plexiglass |
| | 331-0157-00 | | | 1 | GRATICULE, double scale |
| | 331-0077-01 | | | 1 | GRATICULE, blank |
| | 331-0156-00 | | | 1 | GRATICULE, composite, 7 cm |
| | 331-0184-00 | | | 1 | GRATICULE, composite |
| | 331-0185-00 | | | 1 | GRATICULE, composite (installed) |
| -4 | 378-0560-00 | | | 1 | FILTER, light, smoke gray |
| -5 | 351-0040-02 | | | 1 PR | TRACK, slide stationary & intermediate sections |
| -6 | 381-0187-00 | | | 4 | BAR, retainer |
| -7 | 377-0064-00 | | | 2 | INSERT, graticule light, red |
| | 070-0926-00 | | | 1 | MANUAL, instruction (not shown) |

FIG. 4 STANDARD ACCESSORIES



# SECTION 9
# RACKMOUNTING

Change information, if any, affecting this section will be found at the rear of the manual.

## Mounting Method (Figs. 9-1 and 9-2)

This instrument will fit most commercial consoles and most 19-inch wide racks whose dimensions conform to EIA specifications.

Fig. 9-1 shows the instrument installed in a cabinet type rack with slideout tracks. The instrument is locked into the rack by means of pawl fasteners. When the RELEASE knobs on the front panel are turned to release the instrument, the instrument can be pulled out of the rack like a drawer to its fully extended position (see Fig. 9-2) and then tilted up about 100°. This position permits many routine maintenance functions to be performed without completely removing the instrument from the rack. The slideout tracks easily mount to the cabinet or relay type rack front and rear vertical mounting rails if the inside distance between front and rear rails is within $10^{9}/_{16}$ inches to $24^{3}/_{8}$ inches.

Some means of support (for example, make extensions for the rear mounting brackets) is needed to support the rear ends of the slideout tracks if the tracks are going to be installed in a cabinet rack whose inside dimension between front and rear rails is not the proper distance ($10^{9}/_{16}$ inches to $24^{3}/_{8}$ inches).

## Instrument Dimensions and Weight

The last pullout page in this section shows dimensional drawings exclusive of the power cord and cables.

## Rack Dimensions

**Width**—A standard 19 inch rack may be used. The dimension of opening between the front rails of the rack must be at least $17^{3}/_{8}$ inches for a cabinet type rack in which the front lip of the stationary section is mounted **behind the front rail** as shown in Fig. 9-5B. This dimension allows room on each side of the instrument for the slideout tracks to operate so the instrument can move freely in and out of the rack.

**Depth**—For proper circulation of cooling air, allow at least 2 inches clearance behind the rear of the instrument and any enclosure on the rack (see dimensional drawings). At least that much space is also needed for the coaxial cables (unless 90° adapters are used) so they are not bent too sharply. If it is sometimes necessary or desirable to operate the Type RM529 MOD 188D in the fully extended position, use cables that are long enough to reach from the signal source to the instrument.

## Rackmounting in a Cabinet Rack (Fig. 9-2)

### General Information

The slideout tracks for the instrument consist of two assemblies, one each for the right and left sides. Each assembly consists of three sections as illustrated in Fig. 9-3. The stationary section attaches to the front and rear rails of the rack with inside dimensions as shown in Fig. 9-2, the chassis section attaches to the instrument, and the intermediate section allows the instrument to fully extend out of the rack.

The small hardware components included with the slideout track assemblies are shown in Fig. 9-4. The hardware shown in Fig. 9-4 is used to mount the slideout tracks to the rack rails having this compatibility; front and rear rail holes must be large enough to allow inserting a #10-32 screw; rail holes must be located on EIA/RETMA/Western Electric or Universal spacing. Because of the above compatability, there will be some parts left over.

## Stationary and Intermediate Sections Installation

The stationary and intermediate sections for both sides of the rack are shipped as a matched set and should not be separated. The matched sets for both sides are marked 351-0040-02 on the package. Use the following procedure to mount both sets. See Fig. 9-5 for installation details.

NOTE

**If it is desired to mount the rear of the stationary slideout track sections without the bar nuts, then one hole must be drilled and tapped for a #10-32 screw in each rear rail. To locate the desired hole: mount the front of the stationary slideout track section; level the stationary section and mark the required hole location.**

1. If the instrument is to be mounted directly above or below another instrument in the cabinet rack, select the appropriate holes in the front rack rails for the stationary sections using Fig. 9-5C as a guide.

2. Mount the stationary slideout track sections to the front rack rails using Fig. 9-5B as a guide.

3. If the rear rack rail holes have been drilled and tapped as described above for #10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 9-5A. Using Fig. 9-5A as a guide, mount the right stationary section in the same manner.

4. If the rear rack rail holes are not drilled and tapped as described above to accept #10-32 machine screws, mount the left stationary section with hardware provided as shown in Fig. 9-5B. Using Fig. 9-5B as a guide, mount the right stationary section in the same manner.

## Adjustments

To adust the slideout tracks for smooth operation, proceed as follows:

1. Insert the instrument into the rack as shown in Fig. 9-6.

2. Adust the slideout tracks for proper spacing as shown in Fig. 9-7.

## Maintenance

The slideout tracks require no lubrication. The special gray finish on the sliding parts is a permanent lubrication.

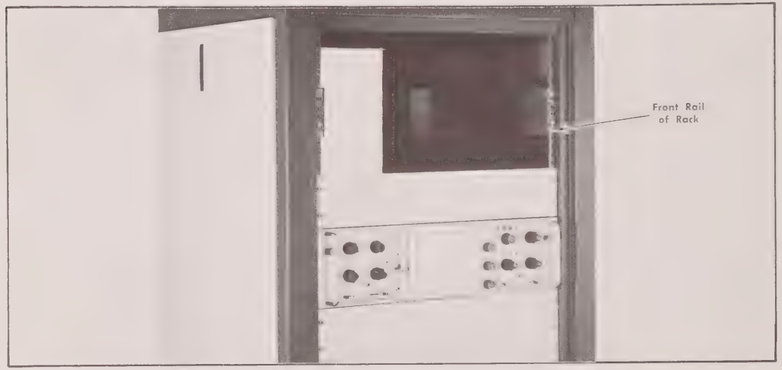



Fig. 9-1. The Type RM529 MOD 188D installed in cabinet type rack.

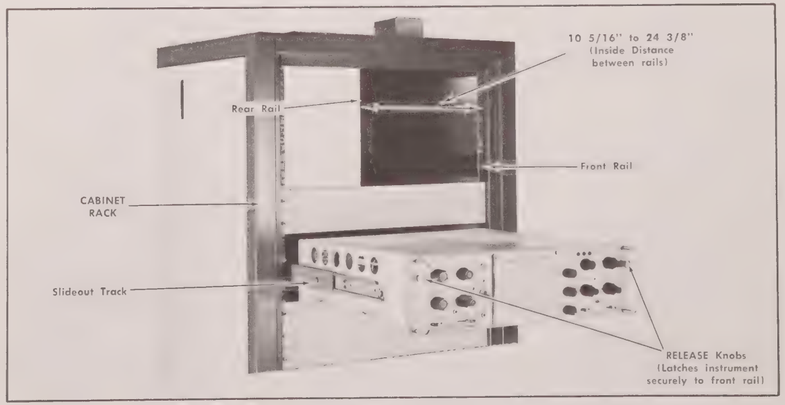



Fig. 9-2. The Type RM529 MOD 188D supported by slideout tracks mounted between front and rear cabinet rack rails.

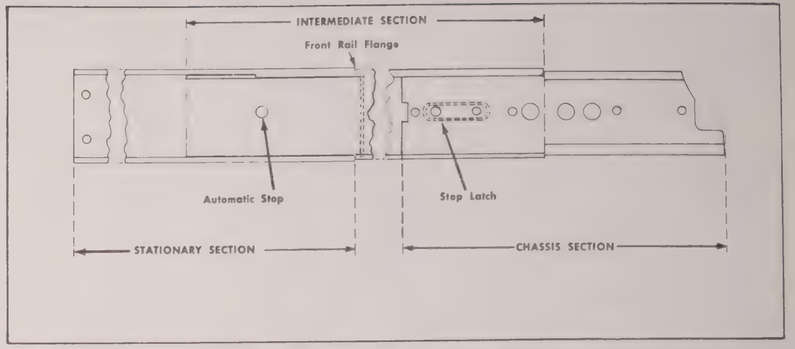



Fig. 9-3. Illustration showing the slideout track assembly for the right side.

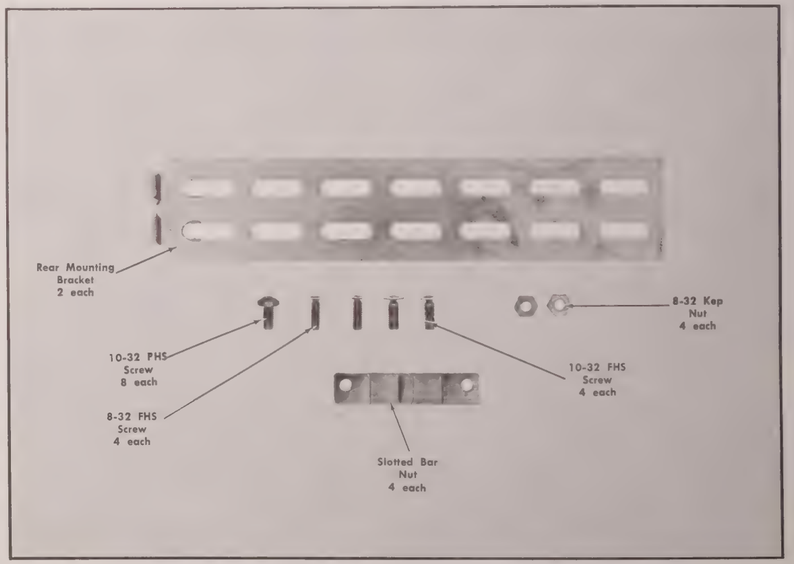
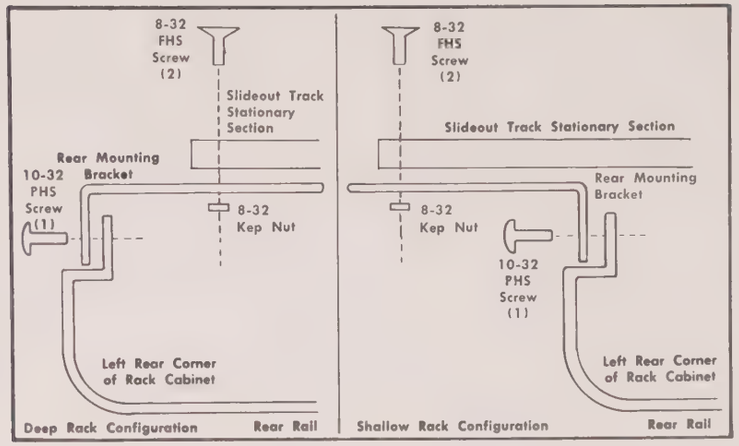
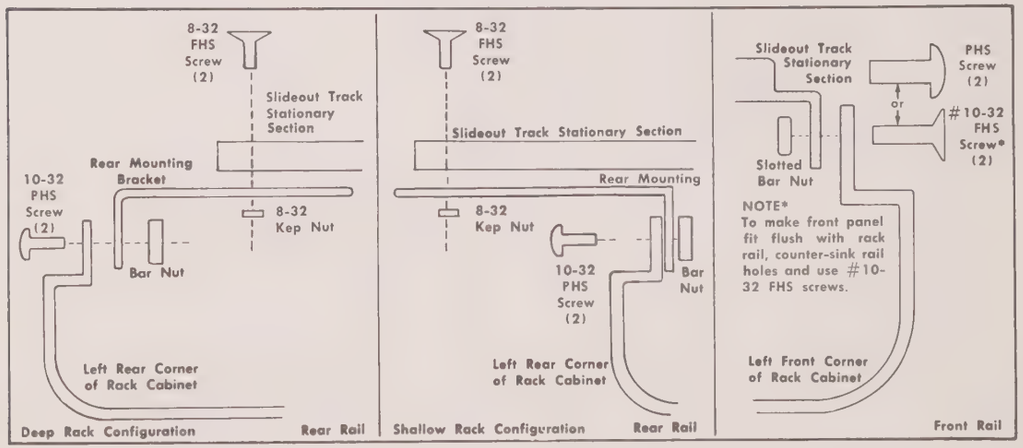


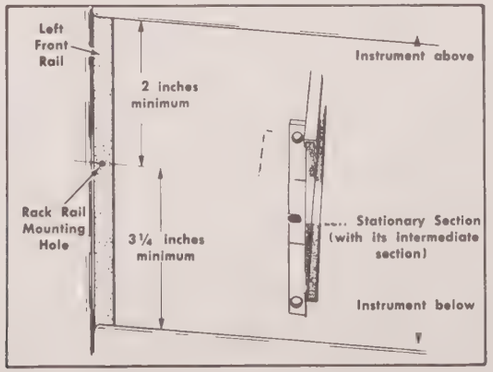

Fig. 9-4. Small hardware components for mounting the stationary sections to the rack rails.




(A) Rear rack rails tapped #10-32.




(B) Rack rails not tapped.




(C) Locating vertical mounting position.

Fig. 9-5. Mounting the left stationary section with its matched intermediate section (not shown) to rack rails.

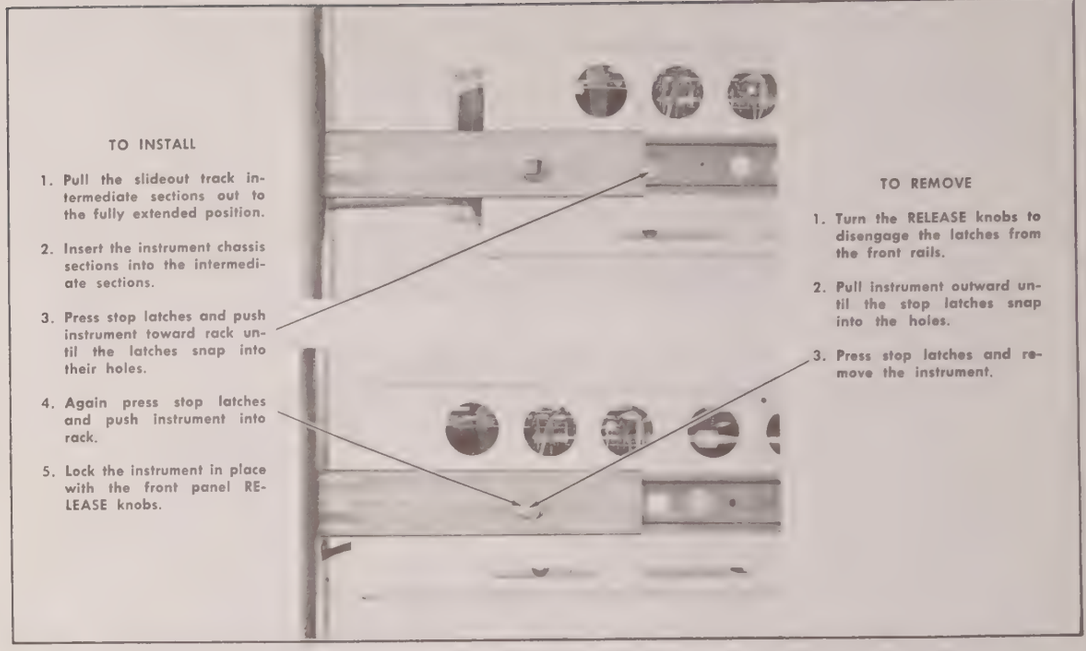

TO INSTALL
1. Pull the slideout track intermediate sections out to the fully extended position.
2. Insert the instrument chassis sections into the intermediate sections.
3. Press stop latches and push instrument toward rack until the latches snap into their holes.
4. Again press stop latches and push instrument into rack.
5. Lock the instrument in place with the front panel RELEASE knobs.
TO REMOVE
1. Turn the RELEASE knobs to disengage the latches from the front rails.
2. Pull instrument outward until the stop latches snap into the holes.
3. Press stop latches and remove the instrument.

Fig. 9-6. Installing and removing the instrument.

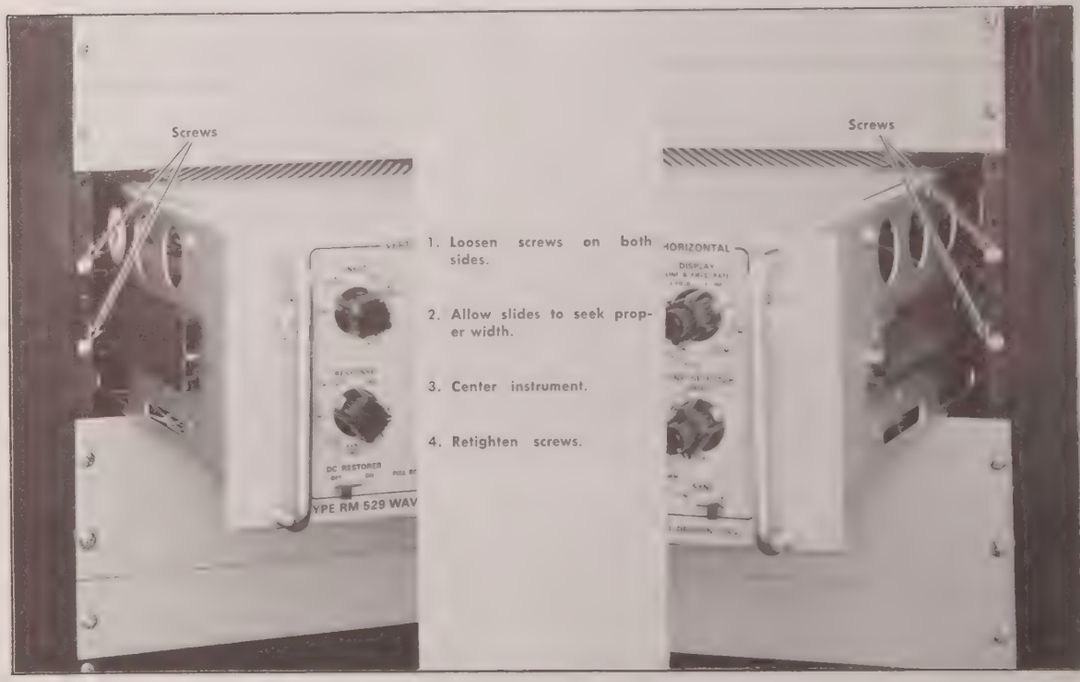
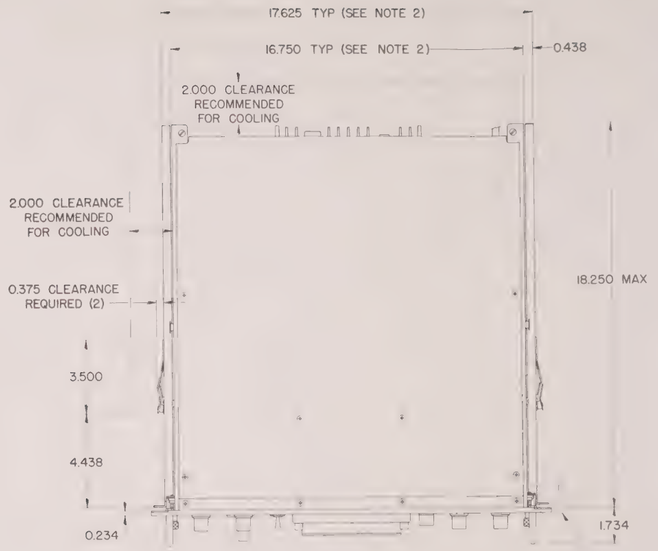
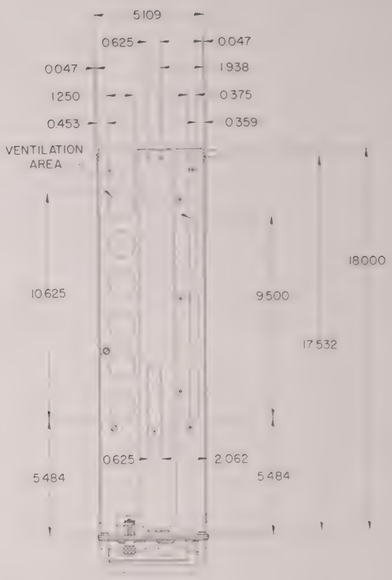


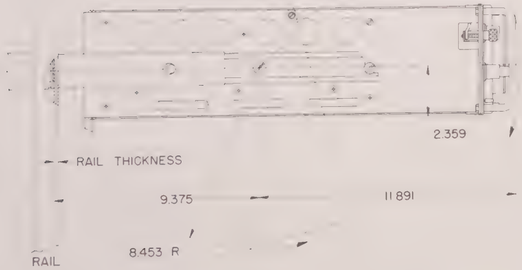

Fig. 9-7. Adjusting the slideout tracks for smooth sliding action.

REAR VIEW




SEE SECTION DETAIL "A"



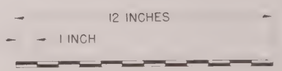


SECTION DETAIL "A"

RECOMMENDED MOUNTING

NOTES
1. ALL DIMENSIONS ARE REFERENCE DIMENSIONS EXCEPT AS NOTED
2. SUBJECT TO APPROXIMATELY ±0.047 DEVIATION

TYPE RM529
MOD 188D




A

## MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

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# MANUAL CHANGE INFORMATION

PRODUCT GENERAL

CHANGE REFERENCE S23,351

DATE 6-10-76 REV.

| CHANGE: | DESCRIPTION |
|---|---|

**This applies to all instruments with detachable cord.**

**WARNING**

*To avoid electrical shock or equipment damage, be sure to replace the cord set only with another of the same polarity.*

**Power Cord Conductor Identification**

| Conductor | Color | Alternate Color |
|---|---|---|
| Ungrounded (Line) | Brown | Black |
| Grounded (Neutral) | Blue | White |
| Grounding (Earthing) | Green-Yellow | Green-Yellow |

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# MANUAL CHANGE INFORMATION

PRODUCT See Below

CHANGE REFERENCE M22,361

DATE 5-28-74

| CHANGE: | DESCRIPTION |
|---|---|

RM529 EFF SN 15700-up
RM 529-188D EFF SN 15700-up
529 EFF SN 15700-up
529-188D SN 15700-up

ELECTRICAL PARTS LIST CHANGES

CHANGE TO:

| | | | |
|---|---|---|---|
| D271 | 152-0185-00 | Silicon | Replaceable by 1N4152 |
| D272 | 152-0185-00 | Silicon | Replaceable by 1N4152 |

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# MANUAL CHANGE INFORMATION

PRODUCT RM529 MOD 188D

CHANGE REFERENCE C4/275

DATE Feb. 26, 1975

| CHANGE: | DESCRIPTION |
|---|---|

SECTION 7 MECHANICAL PARTS LIST, Page 7-1, Fig. & Index No. 16

CHANGE TO READ:

Fig. & Index No. 24

Page 7-2, Fig. & Index No. 24

CHANGE TO READ:

Fig. & Index No. 16